GET READY FOR COMET AUSTIN!

ASTRONOMY®

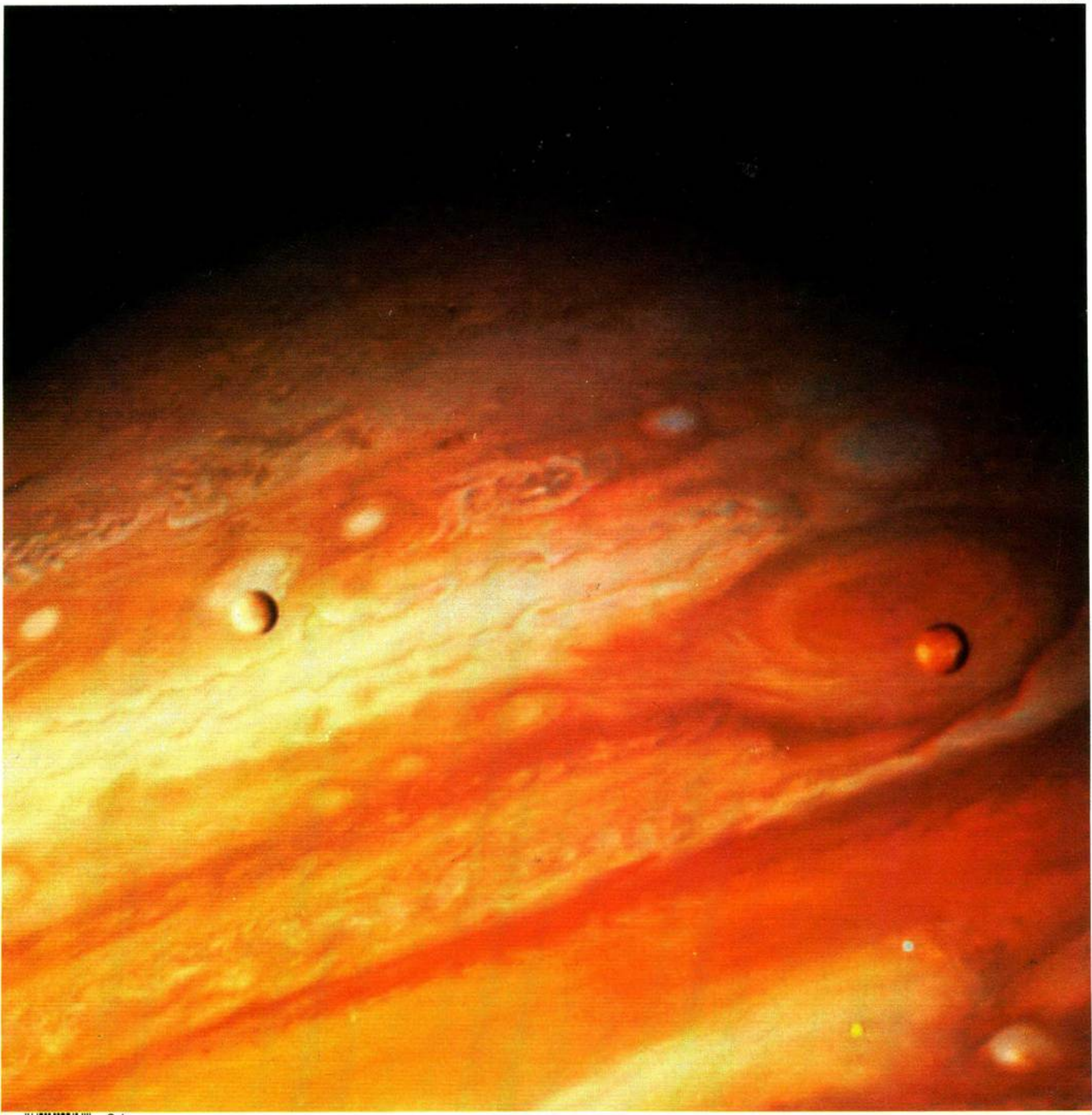
The Fiery Fate of the Solar System

Your Best Year to Observe Pluto

ASTRO Tests an Equatorial Platform

April 1990
U.S. $2.50
U.K. £1.60
Can. $2.95

ICD 08070



Galileo: Revisiting an Old Friend

New Meade® Premier Series™: The

Plug into 8,199 objects with the Meade CAT Computer Aided Telescope system.

Meade 8″ 2080/Model 50. (Shown with DRS.)

Meade 10″ 2120/Model 50H with Superwedge.

Collects 56% more light than 8″ models.

Meade
Init
Mode
Set
2358
-356
N
W
E
S
Focus
Near
Map
Quartz
Manual
Solar
Sidereal
Lunar
Reticle Adjust
U.S.A.

Multi-function, hand-held Electronic Command Center (ECC) is included with, or available for, all Premier Series models.

MEADE PREMIER SERIES 8″ AND

Model	Aperture	f/Ratio	Drive	Wedge	Tripod	Finder	Diagonal	Eyepieces	Accessories[1]
2080/Model 30	8″	f/10	LX6	Standard	Field	6 x 30mm	1.25″	MA 25mm	Package A
2120/Model 30	10″	f/10	LX6	Standard	Field	8 x 50mm	1.25″	MA 25mm	Package A
2120/Model 30H	10″	f/10	LX6	Superwedge	Field	8 x 50mm	1.25″	MA 25mm	Package A
2080/Model 36	8″	f/6.3	LX6	Standard	Field	6 x 30mm	1.25″	MA 25mm	Package A
2120/Model 36	10″	f/6.3	LX6	Standard	Field	8 x 50mm	1.25″	MA 25mm	Package A
2120/Model 36H	10″	f/6.3	LX6	Superwedge	Field	8 x 50mm	1.25″	MA 25mm	Package A
2080/Model 50	8″	f/10	LX6	Standard	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2120/Model 50	10″	f/10	LX6	Standard	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2120/Model 50H	10″	f/10	LX6	Superwedge	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2080/Model 56	8″	f/6.3	LX6	Standard	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2120/Model 56	10″	f/6.3	LX6	Standard	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2120/Model 56H	10″	f/6.3	LX6	Superwedge	Field	9 x 60mm Polar	2″	SP 26mm	Package A
2080/Model 70	8″	f/10	LX6	Standard	Field	9 x 60mm Polar	2″	Package B	Packages A & C
2120/Model 70H	10″	f/10	LX6	Superwedge	Field	9 x 60mm Polar	2″	Package B	Packages A & C
2080/Model 76	8″	f/6.3	LX6	Standard	Field	9 x 60mm Polar	2″	Package B	Packages A & C
2120/Model 76H	10″	f/6.3	LX6	Superwedge	Field	9 x 60mm Polar	2″	Package B	Packages A & C

[1] **Package A:** 115v AC and 12v DC power cords; battery pack. **Package B:** SP 26mm; SWA 40mm; UWA 6.7mm; UWA 14mm. **Package C:** #1200 Electric Focuser; Off-Axis

...Buy Now and Receive $1000 in Meade

$1000
Meade Accessory Coupons
Meade

$1000 Coupon offer is valid at participating dealers in the U.S. and Canada.

Now, for a limited time, you can save $1000 on the purchase of important Meade photo-visual accessories when you buy a Meade 8″ or 10″ Schmidt-Cassegrain telescope. Here's how it works:

1. Buy any Meade 8″ or 10″ SCT model—LX3, LX5, LX6, Premier Series, or Standard 2080—from your participating Meade dealer, between January 1 and April 30, 1990.

2. Packed with your telescope you will receive a booklet of coupons which are as good as cash towards the purchase of a wide range of Meade accessories.

3. Submit one or more of the coupons to the dealer from whom you purchased the telescope, and subtract the value of the coupon from your dealer's best price for the accessories you wish to purchase.

Integrated SCT System...

Meade Premier Series 8″ and 10″ Schmidt-Cassegrains let you buy according to your requirements and budget *now, without sacrificing any upgrade capability in the future.* Purchase the 8″ 2080/Model 30 today, and add the hand-held Electronic Command Center, Digital Readout System, CAT Computer Aided Telescope system, or Electric Declination Motor at any later date—and know that all of these important options integrate readily into the Premier system.

Or, if you're ready for a more advanced instrument now, consider the features and extra value that one of the Meade 50- or 70-series models represents. Either way, you'll be assured of buying a telescope that will not become obsolete as your interests expand. *All Premier Series telescopes include the following standard equipment:*

- **f/6.3 or f/10 Diffraction-Limited Optics**—Legendary *hand-matched,* laser-tested optical quality that has made Meade Instruments the World's leading, and largest, manufacturer of Schmidt-Cassegrain telescopes. No other manufacturer offers you a choice of either wide-field f/6.3 or classical f/10 optics to suit your applications. Meade 10″ models collect 56% more light than 8″ models, at modest additional cost.

- **LX6 Drive System and Power Panel**—The most sophisticated and precise drive system ever offered on a commercial telescope. Includes quartz microprocessor-controlled drive electronics, multi-function display panel, and outlet jacks for available electronic options listed in the table below. The motor drive runs from either 115v AC outlets, or, for field use, from 12v DC auto cigarette lighter plugs.

- **Multi-Coated Optics** — Enhanced coatings on all mirror and lens surfaces that optimize light transmission through the telescope.

- **Field Tripod, Wedge, Finderscope, and Accessories**—All Premier models are supplied as complete instruments, ready to set up and operate.

10″ SCHMIDT-CASSEGRAINS

ECC[2]	EDM[3]	CAT[4]	DRS[5]	Remarks
Optional	Optional	Optional	Optional	*The lowest-cost, fully-upgradable Schmidt-Cassegrains available from any manufacturer.* 30-series SCT's combine f/10 optical systems and the industry's finest motor drive system. "H" models include Superwedge for extreme stability during long-exposure astrophotography.
Optional	Optional	Optional	Optional	
Optional	Optional	Optional	Optional	
Optional	Optional	Optional	Optional	*The lowest-cost f/6.3 Schmidt-Cassegrain ever!* Meade f/6.3 models reduce astrophoto exposure times by 60% compared to f/10 models. Eyepiece for eyepiece, images are 2½ times brighter and fields of view 59% wider.
Optional	Optional	Optional	Optional	
Optional	Optional	Optional	Optional	
Standard	Standard	Optional	Optional	50-series models include hand-held Electronic Command Center and Electric Declination Motor for full dual-axis electronic control of the telescope. Use the 2X speed for precise corrections during astrophotography; flip to 8X speed for image centering and field scanning.
Standard	Standard	Optional	Optional	
Standard	Standard	Optional	Optional	
Standard	Standard	Optional	Optional	Identical to 50-series in specifications, including dual-axis Electronic Command Center, but with fast, wide-field f/6.3 optical system. 2″multi-coated diagonal mirror permits use of wide-angle 2″-barrel eyepieces as well as standard 1.25″-barrel eyepieces.
Standard	Standard	Optional	Optional	
Standard	Standard	Optional	Optional	
Standard	Standard	Standard	Standard	Meade 70- and 76-series are the most advanced and fully-equipped instruments of their types currently available. Included is virtually every accessory required for a lifetime of advanced photo and visual observing: the CAT Computer Aided Telescope system with its 8,199-object memory; Off-Axis Guider/ Illuminated Reticle Eyepiece assembly for long-exposure astrophotgraphy; an assortment of 4 superb eyepieces; and #1200A electric focuser.
Standard	Standard	Standard	Standard	
Standard	Standard	Standard	Standard	
Standard	Standard	Standard	Standard	

Guider; MA 12mm Illuminated Reticle Eyepiece. [2] Electronic Command Center. [3] Electric Declination Motor System. [4] Computer Aided Telescope System. [5] Digital Readout System.

Accessory Coupons!

Accessories available under this special offer include all of the premium Meade photo-visual options that are in greatest demand:

CAT Computer Aided Telescope System—The computerized celestial navigation system that enables the finding of 8,199 objects in seconds. ***Save $200.***

Digital Readout System—Read out celestial coordinates quickly and precisely. ***Save $100.***

Series 4000 Eyepieces—The World's finest oculars for your telescope. ***Save $15 to $25*** on Super Plössls; ***$25 to $50*** on Super Wide Angles; ***$40*** on Ultra Wide Angles.

Plus: Save $10 to $100 on 10 other valuable Meade accessories, from T-Adapters and Off-Axis Guiders to Nebular Filters and Electric Focusers. *Call or visit your Meade dealer today for further details!*

U.S. and Canada Dealer Locations & Assistance

For your nearest Meade dealer location, or for free telescope information and assistance, call Meade Instruments toll-free from anywhere in the continental U.S.A. (except Calif.): **1-800-854-7485.** From all other areas, including California, call direct: **(714) 556-2291.**

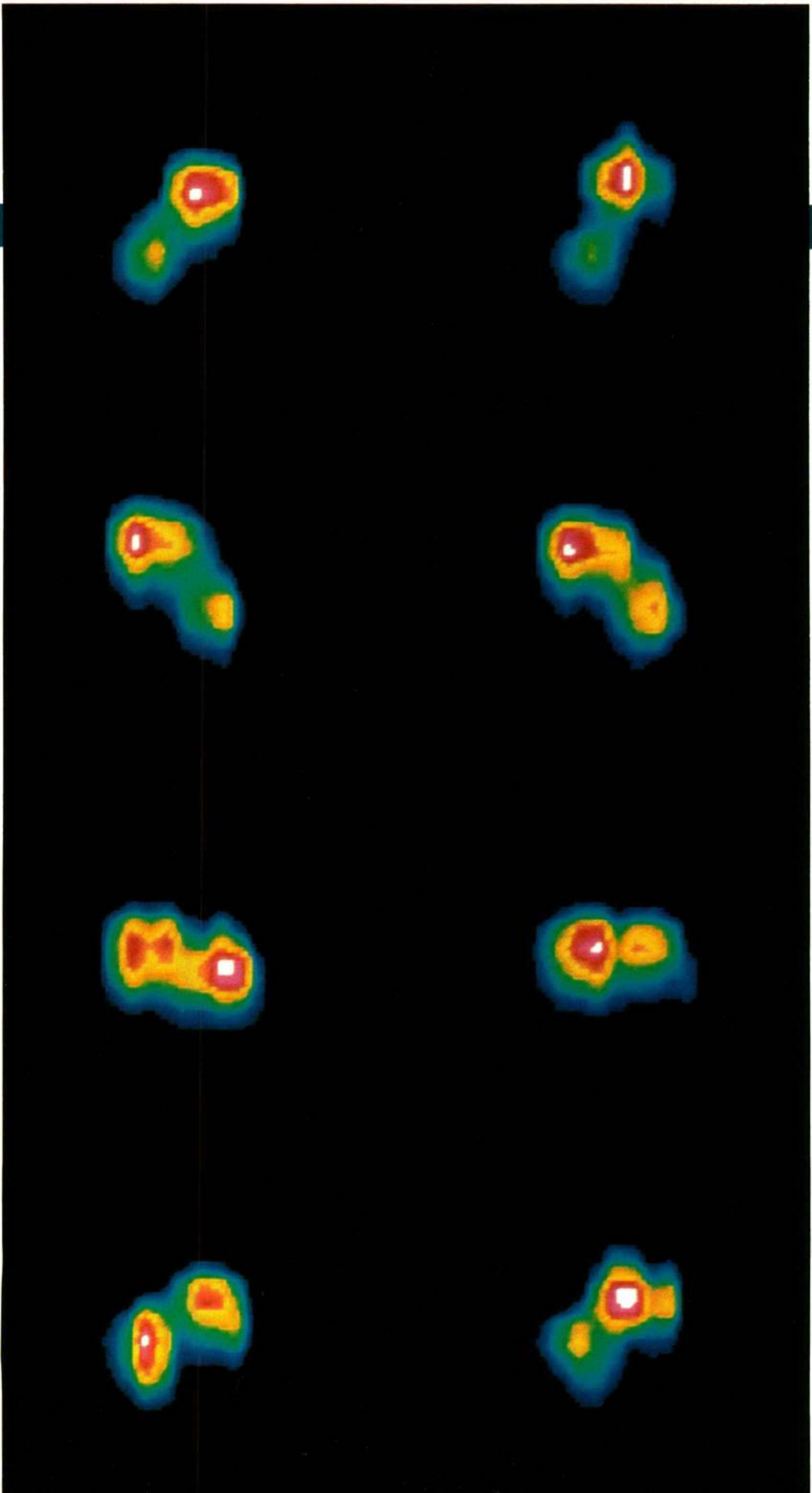
Meade Catalog package #90C—$3.00

Includes 4 separate catalogs and bulletins on the entire range of Meade astronomical telescopes, Series 4000 eyepieces, and accessories.

©1990

Meade Instruments Corporation
World's Leading Manufacturer of Astronomical Telescopes for the Serious Amateur
1675 Toronto Way, Costa Mesa, California 92626 ☐ (714) 556-2291

ON THE COVER: *Galileo* will "rediscover" Jupiter by making long-term observations of the planet's atmosphere, satellites, and magnetic field. (See page 30.) NASA/JPL photo.



TWO ASTEROIDS in one: High-resolution radar images of 1989 PB revealed a rotating double asteroid. (See page 38). NASA/JPL photo.

ASTRONOMY®

April 1990 **Vol. 18, No. 4**

20 The Fiery Fate of the Solar System

Our solar system will be a different place in a few billion years. *Very* different. By Daniel Whitmire and Ray Reynolds.

30 Return to a New World

The *Galileo* mission to Jupiter will allow astronomers to study the Jovian giant in unprecedented detail. By Joel K. Harris.

38 Radar Reveals a Double Asteroid

High-resolution radar images detected a double asteroid as it passed near Earth last August. By Steven J. Ostro.

42 ASTRONOMY Sky Almanac

52 ASTRONOMY Tests a Dobsonian Equatorial Platform

This customized drive platform for big Dobs is designed for visual and photographic use. By Jeff Kanipe.

58 Hunting the Last Planet

If you've always wanted to find Pluto, now is your chance. By Alan Dyer.

64 Five Challenging Globulars

In case you haven't heard, all globulars are *not* alike. By David Higgins.

70 Get Ready for Comet Austin

Don't miss the brightest comet in seven years. By Richard Talcott.

Departments

6 Behind the Scenes

6 Letters

8 Viewpoint
A Spacefaring Nation

10 AstroNews
COBE Results Support Big Bang Theory

16 Space News
Return To the Moon

18 Amateur News
SETI Project in Trouble

77 Reader Reports
Bright Winter Comets

82 Forum

86 Astronomy Books

90 Astronomy Products

94 Meetings and Events

96 Readings and Resources

96 Credits

98 Advertiser Index

ASTRONOMY (ISSN 0091-6358) is published monthly by Kalmbach Publishing Co., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Copyright © 1990 Kalmbach Publishing Co., all rights reserved. Material in this publication may not be reproduced in any form without permission. Second-class postage paid at Waukesha, WI, and additional mailing offices. POSTMASTER: Send address changes to ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187. Telephone: **(414) 796-8776** weekdays, 8:30 a.m. - 4:45 p.m. Subscription inquiries: (800) 446-5489. Allow six to eight weeks for new subscriptions and changes of address. New subscriptions start with current issue. Subscription price: 1 year, $24. All foreign: add $9 per year; please remit in U.S. funds. Send editorial and business inquiries and submissions to the address above. Not responsible for unsolicited materials. ASTRONOMY is indexed in *The Reader's Guide to Periodical Literature*. Microfilms of ASTRONOMY available from University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, MI 48106. Printed in the U.S.A.

The
Audit
Bureau

Behind the Scenes

ANTICIPATING COMET AUSTIN

Just days after Comet Austin's discovery, Rich Talcott walked into my office and announced, "Austin's going to be a good one. Let's do a story." Comet Austin will be in the eastern sky from late April through May, bright enough to see with the naked-eye.

Comet Austin remains bright for so long, explained Rich, because as the comet moves away from the Sun it also draws closer to Earth. So set your alarm clocks for the wee hours. This is a comet you'll want to see. Rich's story begins on page 70.

"Earth will be burned to a cinder in 5 billion years." How often have you heard that? With the help of senior editor Robert Burnham, astronomers Dan Whitmire and Ray Reynolds translated the arcane predictions of stellar evolution theory into a very readable story. The story recalls the joke about an astronomer who gave a lecture about the Sun. After his talk, an obviously worried man asked, "How long did you say it would be before the Sun destroys Earth?"

"Five billion years," replied the astronomer.

"Whew," said the man, visibly relieved, "I thought you said 5 *million.*"

During the coldest nights of the coldest month of the year, Jeff Kanipe was outside evaluating an Osypowski equatorial platform. Jeff finished his article (see page 52) just in time to fly off to Washington, D.C. for a week at the January meeting of the American Astronomical Society.

When you send letters or photos to Reader Reports, Dave Eicher sees them first. Dave has reveled recently in superb reader photographs of comets Brorsen-Metcalf, Aarseth-Brewington, and Okazaki-Levy-Rudenko. Now he's ready for a flood of reports on Comet Austin, so be sure to send your photos and observations. Reader Reports begins on page 77.

Last but not least, I'm pleased to introduce Alan Dyer, the newest addition to ASTRONOMY's editorial staff. Alan comes to ASTRONOMY from the Edmonton Space Sciences Centre in Alberta, where he was program director. Alan is an amateur astronomer of high caliber, an experienced observer, and a fine astrophotographer. He prepared this month's story on observing Pluto in 1990. You can expect many fine contributions from Alan in the years to come.

That's it for April. I trust you'll set that alarm clock to see and enjoy Comet Austin. Clear skies!

Sincerely,

Richard Berry

Richard Berry
Editor-in-Chief

ASTRONOMY

Richard Berry Editor-in-Chief
Stephen Cole Managing Editor
Thomas L. Hunt Art Director
Robert Burnham Senior Editor
Jeff Kanipe Associate Editor
Alan Dyer Associate Editor
David J. Eicher Assistant Editor
Richard Talcott Assistant Editor
Patti L. Keipe Art Assistant
Tracy Staedter Editorial Secretary

Robert A. Maas Publisher
Daniel R. Lance Group Advertising Manager
Gregory J. Swan Advertising Sales Manager
Dana-Lynne Terry Adv. Services Representative

Advertising Department: (800) 558-1544

U.S. Newsstand Distribution
I.C.D., The Hearst Corp., New York, NY 10019
Canadian Newsstand Distribution
Telemedia Dist., Toronto, Ontario M4S3B3
World Newsstand Distribution
Curtis Circulation Co., Hackensack, NJ 07601

Letters

Noisy Sounds of Silence

In response to Elizabeth Lansing's letter "The Sound of Silence" (November 1989), I wish to remind her that most people find music relaxing; otherwise, they wouldn't listen to it. It is also ridiculous to put down Dave Eicher for simply making a suggestion that would make astronomy more enjoyable for many. I frequently listen to music while doing astronomy and find that the music enhances the beauty of the objects I am observing.

If Ms. Lansing finds music irritating, then I suggest she refrain from listening to it! — *Douglas Norton, Summerville, South Carolina*

Say What?

It would seem that the pronunciation of astronomical words has little to do with astronomy. But such is not the case, due to the way speech is sometimes garbled.

If the local art museum presented a lecture by an art authority from the Netherlands, and if he announced, complete with gutteral Dutch pronunciation, that his talk would be on Dutch art from "fer-MAIR" to "fahn Khokh," you would not know he was talking about Vermeer and van Gogh.

Imagine a star party in which the leader (a Latin scholar) urges a budding young astronomer to consult his charts and use his telescope to locate the Whirlpool Galaxy in "KAH-ness-way-NAHT-a-kee." This would discourage him since, aside from being unfamiliar with the sky, he would not know that the man was referring to "KAY-neez-ve-NATT-a-sigh." The moral? When using foreign names or words in an English context, use the Anglicized pronunciation of those words. — *Leland A. Dolan, Houston, Texas*

In Defense of the Dynamax

I noted with some dismay the description of the Dynamax 8 in Alan Dyer's article on the history of Schmidt-Cassegrain telescopes (October 1989). I was a Criterion employee from 1979 to 1985 and performed both mechanical and optical assembly for the Dynamax. I feel Mr. Dyer has unfairly judged the Dynamax telescope. Granted, the company is no longer in business, but that is because of Bausch & Lomb and not because of the Dynamax.

The Dynamax telescope was available in both 6- and 8-inch apertures. The optical quality of nearly every Dynamax 6 is exceptional. The 8-inch telescope was also a superb instrument. The two

Genesis Owner Turned Into Zombie!

Gentlemen:

I would like to say a few words about my new Genesis. I live in a relatively light polluted area, and own an 8" SCT which I have used for about two years. During this time there have been many deep sky objects which I have been unable to locate from my back yard.

I bought Genesis because I wanted a telescope that I could set up quickly to use at home on week-nights. When I began using Genesis, a few weeks ago, I was surprised to find many objects that have eluded me during the past two years. I was even more surprised when I realized that I had been looking in the right places all the time. These objects showed up in Genesis, but not in my 8" SCT.

My back yard experience with Genesis encouraged me to take it to my dark sky observing site which is, at an elevation of 5000 feet above sea level, in the Sierra Nevada Mountains. What I saw there was, in many cases, better than photographs in magazines. I was able to resolve globular clusters to a greater degree than publications indicate.

I didn't expect Genesis to be this good. It really is better than I imagined.

There does seem to be one problem with Genesis. My short week-night observing sessions have become anything but short, and I frequently arrive at work feeling and looking very much like a zombie. I guess that no telescope can solve all of your problems. In any case, thanks for the ones you did solve.

- George N. Storm, California

Photo by Jim Riffle

Unsolicited comments from warranty cards

- *It's beautiful, from case to scope.* C.C. The Netherlands
- *Fantastic! Great photo resolution, best optics ever owned and I'm a Hasselblad & Nikon fan. Now my best item.* D.B. New Jersey
- *This is my 1st scope and I'm having a wonderful time finding the limits of the instrument and my locating abilities.* G.P. New Jersey
- *Very pleased with your new improvements.* J.F. California
- *Even though cost was more than an 8" SCT with mount, quality & convenience won out. I will only use Tele Vue optics, mount and accessories.* W.B. Indiana
- *The telescope lives up to its expectation.* T.W. England
- *Wanted a 2nd telescope that was portable, delivered wide fields and superb images. Genesis is all I hoped for. The sharpness is astonishing and it's very portable.* G.H. Canada
- *Sold my 8" SCT looking for better images.* P.F. New York
- *Fantastic! My wife could not see Trapezium etc. with old scope. Now can't get her away from eyepiece: you have right to be enthused about your product.* W.J. Canada
- *I just wanted to have one excellent telescope to do astrophotography. Fantastic. Awesome.* J.J. California
- *Beautiful equipment - Total satisfaction with first use. Keep up the good work.* M.C. Ohio
- *I wanted a very high quality refractor. I was told by many - "This is it." This is a beautiful instrument!* M.F. Florida
- *Remarkable! I always wanted a 4" fluorite refractor. Sold my (8" SCT).* T.S. Indiana
- *Compactness & quality - a beautiful, fantastic instrument.* J.V. The Netherlands

- *It's the best 4" refractor made.* A.A. California
- *I was looking for the best first telescope I could buy. Something small. I never saw images clearer and more distinct than in Genesis.* G.D. Canada
- *Genesis is the only scope in the race. I wanted the best and believe I got it.* E.S. Australia
- *As the apparent equal of a (Maksutov), with the added RFT capability, Genesis is 'the', to me, obvious choice for portable astronomy. I'm completely satisfied.* R.A. Georgia
- *Very Impressive - my first view was of Pleiades with a 40mm Wide Field. The observation was remarkable, crisp, bright and jewel-like.* P.L. Massachusetts
- *The best on the market.* E.B. England
- *I bought this telescope without having seen it in-person, based on its specification & your reputation for quality. As usual, I got more than I expected with Tele Vue products...* K.L. Texas
- *My friend borrowed it & won't give it back!!* T.L. Canada
- *I wanted portability and very high quality optics. I have waited many years to be able to afford this telescope, - it was worth waiting for.* P.H. Australia
- *Superior to other 4" scopes on offer.* Z.V.S. South Africa
- *Had SCT, poor contrast/resolution. Tele Vue just the opposite, also it's more portable.* W.S. Connecticut
- *I purchased this instrument because:*
  1) Apo-refractor - basic design
  2) Tele Vue reputation
  3) Dealer owns same model
  U.B. Canada
- *Genesis is as good as gold...Maybe better!* F.G. California
- *I compared specs of Tele Vue vs (other high performance refractors); T-V best choice for $.* R.A. New Hampshire
- *Magic.* C.H. England

My sincerest thanks to all who've written us with such kind comments. I look forward to reading yours.

Al Nagler

Tele Vue

20 Dexter Plaza, Pearl River, NY 10965
(914) 735-4044

dozen people who worked for Criterion took great pride in their craftsmanship.

The "cardboard tube" Mr. Dyer mentions in his article was not cardboard, but a phenolic resin that was dimensionally stable under any observing conditions. — *Gilbert J. Violette, Ellington, Connecticut*

Which Way to Copernicus?

I observe with an 8-inch SCT with a star diagonal. Because I live in a city, I look at the Moon a lot, especially when entertaining friends. They find it more interesting to stare at craters like Copernicus than to spot M31, which is barely visible from the city.

The SCT with star diagonal has north at the top of the field but east and west are reversed. Every lunar map I've found has north at top but does *not* reverse east and west, so the views in my scope do not match the charts. Are you familiar with any lunar maps made for users of star diagonals? — *Brian Zemach, Chicago, Illinois*

— The short answer to your question is, no. We have not seen any Moon maps that are reversed left-for-right. However, we suggest you make a photocopy of the sections you need of your Moon map, turn it over and place it on a red-bulb light box, thereby illuminating it from behind. The names of features would be reversed, but you could pencil them in on the back of the copy. The topographic detail would then be oriented correctly for a star diagonal.

Expanding the Horizons

I want to thank ASTRONOMY, and my son Eric, for expanding my horizons by making it possible for me to see Mercury on October 11 and 13, 1989.

My young son Eric and I awoke at 6:30 a.m. on October 11. After giving Eric a bottle of milk and getting him dressed, we went out to get the paper and saw, directly over our neighbor's roof, dazzling Mercury. We made a repeat sighting on the 13th.

Now I'm working on seeing Uranus, Neptune, and Pluto, but I'll need to get a telescope before I can see all three! — *Robert E. Schorry, Cincinnati, Ohio* ☐

ASTRONOMY welcomes comments, corrections, and additional information on articles and astronomy in general. Send your letters to: ASTRONOMY Letters, P. O. Box 1612, Waukesha, WI 53187. Letters may be edited for length or clarity.

RECIPE FOR A SPACEFARING NATION

by Bruce Murray
professor of planetary science at the California Institute of Technology and president of the Planetary Society.

Until last July, the United States manned spaceflight program seemed without a purpose. Nearly two decades focused on the shuttle had left America with the priciest access to space of any nation. Nor did we exercise in the 1980s the kind of space leadership that Japan, Western Europe, and the Soviet Union did.

Mars is humanity's best hope for a future beyond Earth.

When President Bush pointed us "back to the Moon . . . and this time to stay," he was careful also to say "the Moon is not a destination, it's a direction." A lunar outpost program can help NASA direct manned spaceflight toward a real and worthy objective: manned flight to Mars.

Mars is humanity's best hope for a future beyond Earth. The United States *must* be prominent in this endeavor if we are to remain a major spacefaring nation. I think the following steps are crucial.

1. International Cooperation

The new Moon/Mars program needs to capture the imagination of Americans outside the aerospace community. But how can this be done, given concern over the federal deficit? The key is a program grounded in international cooperation, both with our allies and the Soviet Union. Many Americans are excited by the idea of pioneering a new era in which nations join to explore the space frontier. We must remove space cooperation, especially American/Soviet cooperation, from the diplomatic closet and give it careful technical scrutiny.

2. Rethink the Space Station

The Space Station must reflect the new priorities yet have a realistic price tag. This requires rethinking its functions. Space Station *Freedom* could be a spaceport for flights to the Moon and Mars, but a serious compromise hangs over its current design.

The safest and cheapest way to build a station is with an unmanned Heavy-Lift Vehicle. This would ferry up the main elements in relatively few flights, much as Skylab was boosted using a single unmanned Saturn V. The current U.S. plan requires nearly thirty Shuttle flights to carry up small pieces of the station for risky, on-orbit assembly. However, just five HLV launches could halve the number of shuttle flights.

3. Why Go to the Moon?

Why return to the Moon if the real goal is Mars? Intermittent human missions to the Moon can give us some valuable experience for the Mars endeavor. And NASA feels the need for renewed lunar flights to rebuild its capabilities. Also, a Moon outpost can enable worthy lunar scientific projects, such as radio observations of the cosmos from the Moon's far side, which is shielded from terrestrial radio interference.

4. Can Humans Survive?

We don't know whether humans can endure the weightless months necessary for a Mars trip and then function effectively on its surface. But this knowledge is critical in designing a manned Mars mission. For example, if the crew needs artificial gravity, this physiological requirement would govern the design of any Mars ship.

The Soviets, of course, have made long flights in *Mir*, including a 365-day trip. However, the limited biomedical data available are inadequate to resolve with confidence the Mars flight issue. Why not a joint program of astronauts and cosmonauts flying in *Mir*, supported by a strong U.S. contribution in biomedical studies?

5. Send Robots First

We must study the terrain of Mars through ultra-high resolution imagery. We must sample its atmospheric winds. We must identify potential hazards posed by dust and the chemical reactivity of the Martian soil. And we must know if there is extractable water there. Aside from mission concerns, Mars offers a treasure trove of science relevant to our own planet's history. Robot survey craft can provide immediate scientific benefits even as we gather resources for the giant human adventure to follow.

The President has given voice to the hopes and aspirations of many. Now NASA, Congress, and the rest of us must reach beyond pork-barrel politics and space fantasies to create a bright and realistic future in space. ☐

YOU DON'T NEED A LARGE TELESCOPE TO DO PROFESSIONAL QUALITY WORK

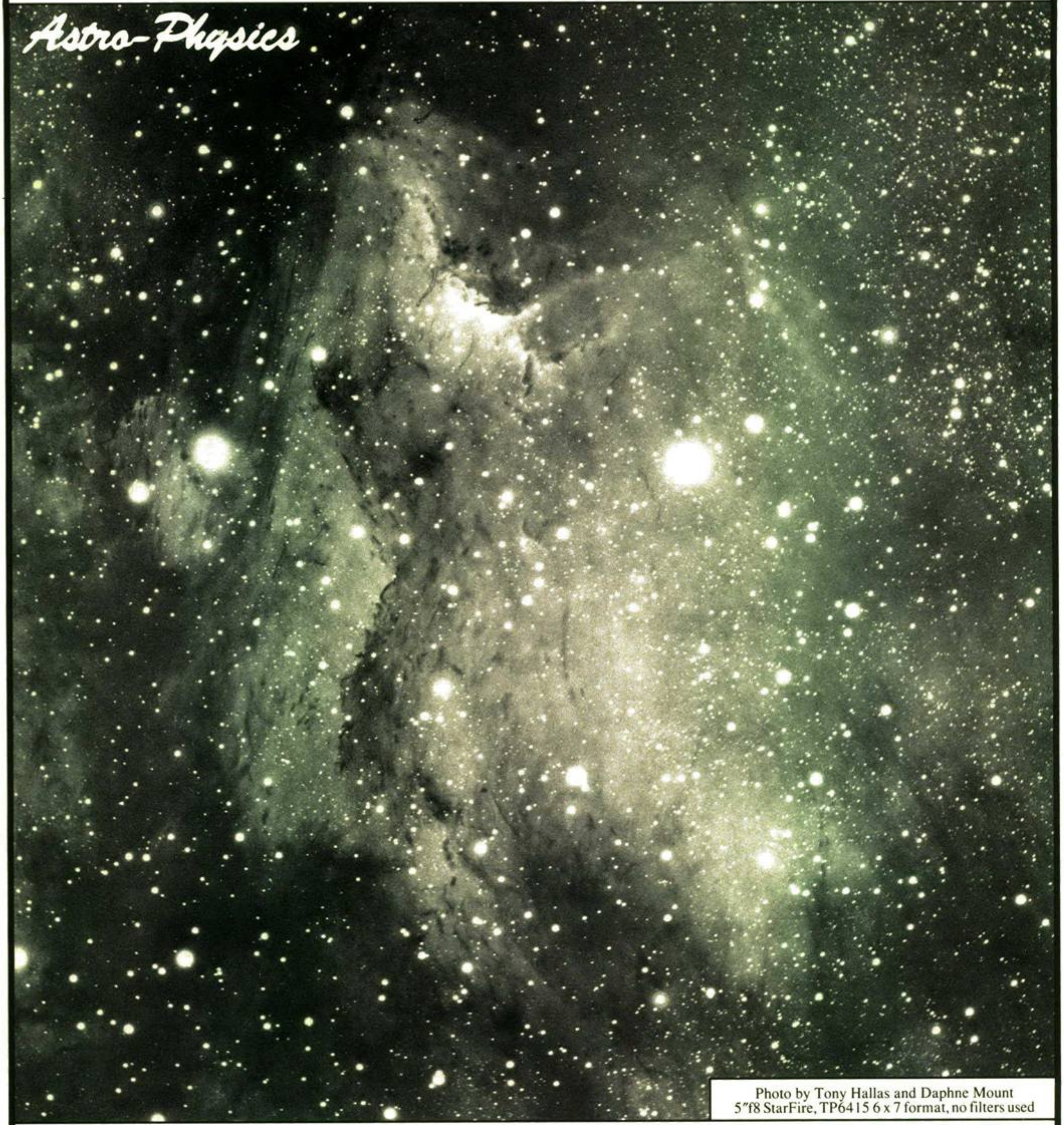


Photo by Tony Hallas and Daphne Mount
5″f8 StarFire, TP6415 6 x 7 format, no filters used

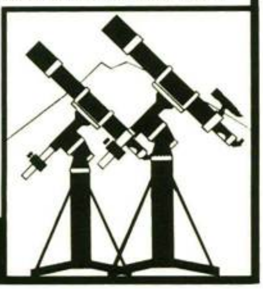
TECHTALK What is a high resolution lens?

We define it as an object glass that focuses a large portion of the visible spectrum (C to F wavelengths) into a tight spot smaller than the Airy disc (approximately 10 microns for an f8 lens). It also must focus the photographic spectrum (R to G wavelengths) into as small a spot diameter as possible across a large field. The 5″f8 lens is capable of 40 micron spot diameters at the edges of a 2.5″, 3.6 degree field. This gives the lens the ability to capture very tiny detail on fine grained film that can then be enlarged to poster size without fuzzing out. It also allows the lens to be used as a high power planetary telescope, fully capable of resolving low contrast planetary detail without resorting to filters.

To achieve this level of performance requires high surface accuracy. Instead of fancy aspherics, the StarFire lens uses an all spherical design to achieve spherical aberration correction and negligible sphero-chromatism. This assures the smooth surface profile so important to crisp image detail and high contrast. Surfaces are checked by test plate interferometer methods, and the final figure and color correction is verified on a double pass autocollimator. Because of the all spherical design and our ability to test each surface separately, we can guarantee a high resolution lens every time.

This stunning photograph of the Pelican Nebula in Cygnus was taken with our 5″ StarFire on the 800 mounting. Guiding was done with a separate 3″ guidescope. The Pelican area shown above is approximately 1/3 of the original 6 x 7 format. This reproduction can only hint at the incredible detail visible on the full negative. Tony remarked that even in 16 x 20 enlargements, the smallest stars remain only pinpricks, and some close doubles require a 40″ print to adequately resolve. This is only one of many photos that we have received from Tony that show the level of detail that a precision lens can record on hypered fine grain film.

ASTRO-PHYSICS telescopes are designed for the discriminating amateur. Our optics are hand corrected in our own optical shop. We can deliver lenses or complete telescopes with precision equatorial mountings.



Astro-Physics

7470 Forest Hills Road
Department A

Loves Park, IL 61111
Phone: (815) 282-1513

COBE RESULTS SUPPORT BIG BANG THEORY

Preliminary data from the Cosmic Background Explorer (COBE) satellite, reported at the January meeting of the American Astronomical Society in Arlington, Virginia, indicate that the background radiation — thought to be the residual radiation of the Big Bang explosion — is extraordinarily unvarying in brightness and temperature across the sky.

George Smoot, principal investigator for the differential microwave radiometer experiment, displayed the first brightness-variation maps of the cosmic background radiation on the final day of the meeting. The maps, taken at 31, 53, and 90 gigahertz, indicate that the cosmic background is equally uniform in all directions.

This uniformity poses a fundamental problem for astronomers who are trying to understand how galaxies could form in such a serene, smooth universe. Astronomers think that the seeds of galaxies and galaxy clusters should be detectable today as variations in the microwave background.

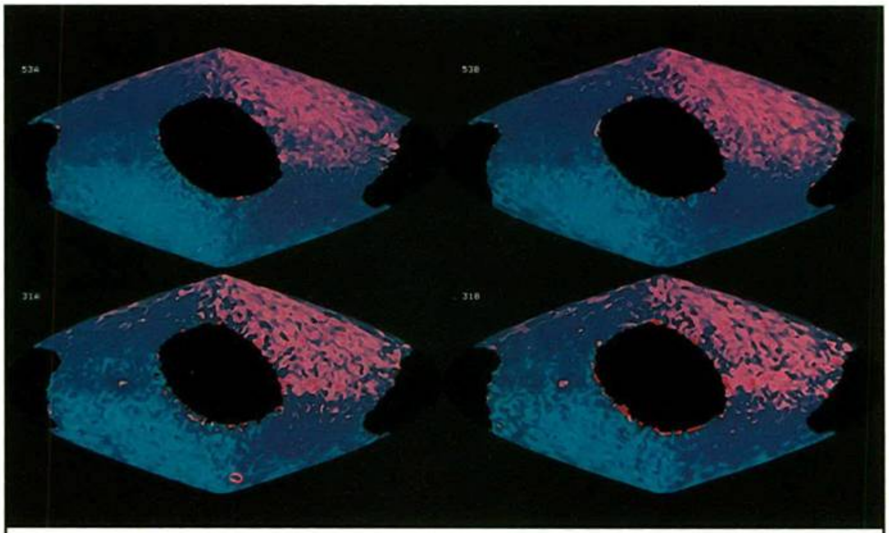
"Any structure in the early universe," said Smoot, "will leave an imprint that we should be able to see today." But since no imprint has yet been found, "we're still stuck with the question of where the galaxies came from."

John Mather, principal investigator of the far infrared absolute spectrophotometer experiment, designed to obtain a spectrum of the background radiation, is confident that his instrument would have already detected significant variations if any existed.

"We can look back and measure the color of the radiation and see energy releases back to one year after the Big Bang," Mather said. "This is farther back than any other instruments. We see no deviation whatsoever [from the prediction of a smooth Big Bang]."

The spectrum of the microwave background shows no variation from a blackbody spectrum (a hypothetical perfect emitter of thermal radiation) as large as 1 percent of the peak brightness of the cosmic background over a wavelength range of 0.5 millimeters to 5 millimeters. This spectrum represents the most precise cosmic microwave background measurement ever made.

COBE will continue to collect data over its projected two-year lifetime. The final data is expected to be ten times more sensitive than these early results.



A SMOOTH, FEATURELESS EARLY UNIVERSE was all that COBE saw when it mapped the cosmic microwave background in two channels (A and B) at frequencies of 53 GHz (top) and 31 GHz. The pink color and the light blue color in each image are Doppler-shift variations in the background caused by the motion of the solar system relative to matter in our galaxy. The patchiness of the background will smooth out as more sensitive measurements are made. The black areas are regions of the sky not yet observed by the instrument. Photo courtesy of NASA and the Goddard Space Flight Center.

BIRTH OF TWIN QUASARS TRIGGERED BY GALAXIES

An international team of astronomers has found what may be the birth of a twin quasar. At this January's meeting of the American Astronomical Society in Arlington, Virginia, Georges Meylan of the Space Telescope Science Institute, S. George Djorgovski and Nick Weir of Caltech, and Peter Shaver of the European Southern Observatory, reported resolving an object known as PHL 1222, situated near the celestial equator in Pisces, into a pair of quasars.

The quasars are separated by only 3.3 arcseconds on the sky, which corresponds to less than 100,000 light-years at the distance of the two quasars, about 12 billion light-years. Meylan thinks the two quasars are so close together that they may be gravitationally interacting. "We may be witnessing the triggering event responsible for the nonthermal activity of both objects," he said. "In other words, the birth of two quasars."

Images of the quasar pair were first taken with the 40-inch telescope of the Las Campanas Observatory near La Serena, Chile. Spectra and additional images were obtained with the 3.6-meter and 2.2-meter telescopes of the European Southern Observatory on Cerro La Silla, also near La Serena, and with the 200-inch and 60-inch telescopes at Palomar Observatory.

It was first thought that the two images might be produced from a single quasar that was split into two images by the gravitational field of an intervening galaxy, a phenomenon known as a gravitational lens. But the quasars' spectra are different enough to convince astronomers that these are in fact two distinct objects. Moreover, Doppler shifts measured in the spectra indicate that the two quasars are approaching each other with velocities typical of those among galaxies in clusters.

The finding suggests that quasars may be activated by close encounters between galaxies. According to this scenario, gravitational tidal effects exerted during these encounters pull out filaments of dust and gas from both galaxies. A large fraction of this material is drawn into an accretion disk surrounding a supermassive black hole at the core of each galaxy. Much of this gas jets outward along the magnetic poles of the black hole. The energy released

CELESTRON:
Quality That Lasts A Lifetime

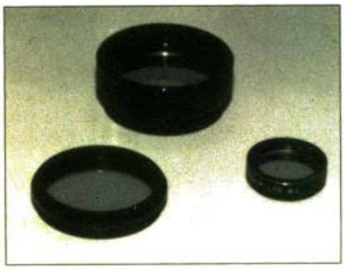
CELESTRON
Advanced Astro Master
MODE
ENTER
UP
RETURN
OFF ON

ADVANCED ASTRO MASTER

Real time digital read-out of R.A. and DEC coordinates. Will guide you to over 8000 objects in its memory, including the RNGC catalog, Messier catalog and over 400 interesting single and double stars. Streamlined, compact design. Quick and easy to install. (*Item* #94145)

COLORED EYEPIECE FILTERS

Invaluable for lunar and planetary work. Reduce glare and light scattering, increase contrast by selective filtration. Increase definition and resolution, reduce atmospheric refraction, reduce irradiation and lessen eye fatigue. Available for both .96″ and 1.25″ eyepieces.



LPR FILTERS

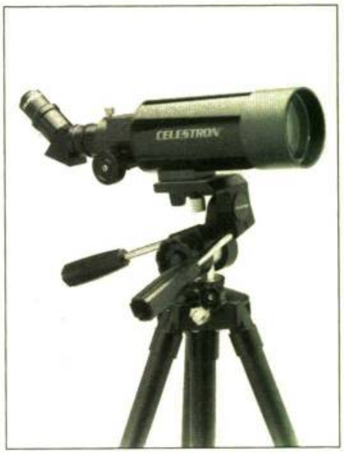
Selectively reduce the transmission of certain wavelengths of light, particularly artificial light. Also block unwanted natural light (sky glow) caused by neutral oxygen emission in our atmosphere. Constructed of high quality flat, polished optical glass. 40 plus layers of state-of-the-art coatings prevent ghosting and improve contrast. Available for 1.25″ eyepieces, 2″ eyepieces and one for the rear cell of C8s.

OFF-AXIS GUIDING SYSTEM

Sharpen your astrophotographs by combining Celestron's Off-axis Guiding System with a drive corrector. The Off-axis Guiding System employs the same optical system for guiding as used to take the photograph. The Off-axis Guiding System includes a Guider Body, Illuminated Reticle Ocular and Battery Pack. (*Item* #93589)

SP-C102F

102mm refractor with multi-coated, diffraction limited, fluorite objective lens. 900mm focal length, f/8.8. Includes: Super Polaris equatorial mount with slow-motion controls, 6x30 finderscope, 26mm Plössl eyepiece-1.25″, illuminated Polar alignment aiming telescope, 45° erect image diagonal, azimuth and altitude fine adjustments, setting circles, adjustable wood tripod and more. (*Item* #21013)



SS80

Premium multi-coated 80mm refractor. 400mm, f/5 system. Includes: 18mm Orthoscopic eyepiece-1.25″, 45° erect image diagonal-1.25″, photo tripod adapter (¼x20), carrying case. (*Item* #51028)

SOLAR FILTERS

Durable Mylar filters available to fit all Celestron telescopes. Lightweight and affordable! Transmits .001% of visible light, allowing direct observation of the sun. See sunspots and granules. Blocks 99.999% of invisible infrared light for safe and comfortable viewing.

STEREO BINOCULAR VIEWER

3-D effect observing. Adapts two eyepieces to the telescope for simultaneous viewing. Greatly improves contrast and definition on lunar, planetary and solar subject matter as well as on deep sky objects. (*Item* #94122)

See your dealer for information on these and other fine Celestron products. Complete Accessory Catalog or Telescope Brochure available for $1.00 each.

CELESTRON®
Celestron International
2835 Columbia St., Torrance, CA 90503
(213) 328-9560
Call free 1-800-421-1526 (M-F 8-4 pm; Pac. Time in Cont. USA)

Meade & Celestron
LUMICON Carries a full line of telescopes & accessories. Fast Delivery, competitive prices.

LUMICON FOR HIGH PERFORMANCE

ASTROPHOTO OF THE MONTH

The "Flame Nebula" NGC 2024 in Orion. Also known as the "Christmas Tree" or the "Tank Trucks" nebula. NGC 2024 is seen best usually with either a LUMICON DEEP-SKY or UHC filter. Photo by Don N. Reiners, 16" f/5, 40 min. using hypered 2415 film and a LUMICON 2" EASY-GUIDER.

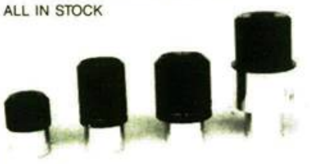
20mm NAGLER

Also new 12mm & 16mm NAGLERS

TELE VUE™ EYEPIECES

USE THE BEST!!

ALL IN STOCK



Genesis 4" f/5.5 Fluorite Apochromat	$1450
Renaissance 4" f/5.5. Telescope	$1450
7.4, 10.4, 13, 17, 21, 26mm Plossl, 50°	$89
1.8X or 2.5X Tele Vue Barlow Lens	$89
32mm Plossl, widest true field in 1¼"	$109
55mm 2" Plossl, widest possible field	$219
15mm Wide-Field, 1¼" eyepiece, 65°	$135
19mm Wide-Field, 1¼" eyepiece, 85°	$145
24mm Wide-Field, "superb," 65°	$169
32mm Wide-Field, 2" eyepiece, 65°	$239
40mm Wide-Field, "awesome," 65°	$299
4.8mm Nagler, 82° field	$149
7mm Nagler, 1¼" eyepiece, 82° field	$189
9mm Nagler, 82° field, "the best"	$219
11mm Nagler, 82° field, 1¼" or 2"	$235
13mm Nagler, 82° field, 1¼" or 2"	$249
12mm Nagler, Type II, 82°, 1¼"/2"	$249
16mm Nagler, Type II, 82°, 1¼"/2"	$289
20mm Nagler, Type II, 82°, 2" only	$340

ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

LUMICON Adjust. Piggyback Mount .. **$54**
Specify telescope size: 6", 8", 10", 11", 14", 16"

H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

Specify Lens Size	**H-Alpha**	**(MV)**
46, 48, 49mm	**$39.00**	**$34.00**
52, 55, 58, 62mm	**$49.00**	**$39.00**
67, 72, 77mm	**$59.00**	**$49.00**
82mm	**$69.00**	**N/A**

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

LUMICON®

2111 Research Dr. #5A, Livermore, CA 94550
For phone orders please call (415) 447-9570
FAX (6 PM-9AM PST) (415) 447-9589
LUMICON Products catalogue $2
All foreign orders add 6% ($8 minimum)
California residents add 6% tax.
Prices subject to change w/o notice.
Hrs: M-F 9 am - 5 pm, Sat. 11 am - 3 pm

NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. 1.3-1.8" mirrors have enhanced silver coatings (98-99%R). The extra 8-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32"	**$29.95**	1.52"	**$34.50**	1.83"	**$39.50**
2.14"	**$49.50**	2.60"	**$65.00**	3.10"	**$89.50**
4.25"	**$149.50**	4.00"	**$149.00**		

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with 98-99% reflectivity enhanced silver mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

1¼" (1.32" mirror)	**$99.50**
2" (1.83" mirror)(see photo above)	**$159.00**

LUMICON FILTERS STOP LIGHT POLLUTION

UHC Filter™

ULTRA HIGH CONTRAST

The **LUMICON UHC FILTER** is specially designed for visual astronomy in areas of severe light pollution or for viewing very faint nebulae at any location. **UHC** stands for **U**ltra **H**igh **C**ontrast and this filter is guaranteed to yield a higher visual contrast on planetary and emission nebulae than any other filter at any price. 24nm visible bandpass, 482-506nm. Transmission = 90-97%.

For optimum astronomy, use either the **LUMICON DEEP-SKY Filter or the LUMICON UHC Filter**

"I CAN SEE THE OWL NEBULA!"

Tom Kramer saw the Owl Nebula, M-97, for the first time using a LUMICON UHC Filter. He stated, *"I had never seen M-97. . . I attached the UHC Filter and tried again. M-97 was right there. I could not believe it! The UHC Filter should be standard equipment."*

Tom Kramer, Sayville, NY

DEEP-SKY FILTER™

The **LUMICON DEEP-SKY FILTER** improves your view of **all** deep-sky objects including galaxies and comets. It removes natural and man-made light pollution and yields 3-6x contrast gain for nebulae and 1-3x contrast gain for clusters and galaxies. It is ideal for **both** visual use and B&W or color photography. This gentle filter yields the most natural view of any LPR filter available today. 90nm visible bandpass. 442-532nm. H-Alpha 656nm transmission = 85-95%. Visible transmission = 85-95%.

	Premium*
0.96" LUMICON DEEP-SKY Filter threads into most 0.96" eyepieces	**$59.50**
1¼" LUMICON DEEP-SKY Filter threads into most 1¼" eyepieces	**$79.50**
48mm LUMICON DEEP-SKY Filter (1.75" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS	**$119.50**
2" LUMICON DEEP-SKY Filter (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography	**$119.50**
72mm LUMICON Giant DEEP-SKY Filter (62, 67, 77mm adapter, $8)	**$299.50**
1¼" LUMICON UHC Filter threads into most 1¼" eyepieces	**$99.50**
48mm LUMICON UHC Filter (1.75" aperture) fits most 2" eyepieces	**$199.50**
Set of Both premium **DEEP-SKY** and **UHC Filters** (Save 11%), Premium	**$159.50**
LUMICON H-BETA Line Filter (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** **$99.50, 48mm**	**$199.50**
Oxygen-III Filter for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines **1¼" $99.50, 48mm**	**$199.50**
Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm	**$6.95**
Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece	**$16.00**
Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece	**$20.00**

**Premium filters are selected best of the lot and typically have 5-10% higher transmission. All Lumicon filters include individually measured transmission data.*

DEEP-SKY ASTROPHOTOGRAPHY

SR-V 3200 NEW FILM

FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295**

MODEL 600 HYPER-KIT (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT **$65**

Electric Vacuum Pump, Model R-10 **$295**

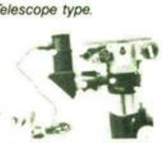
GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.

Specify Camera and Telescope type.

U.S. Patent 4,448,500

NEWTONIAN EASY-GUIDER™



Full aperture. Installs in seconds. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER	**$169.50**
3X Relay Diagonal (see photo)	**$89.50**
Illuminated reticle eyepiece system	**$99.50**

Guider for Hasselblad **$350,** Mamiya 645 **$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad **$185,** Mamiya 645 **$159**

GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ...... **add $99.95**
Adapter for Hasselblad **$195,** Mamiya **$96**

WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector** . **$219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.

Declination motor (state telescope) .. **$99**
NEW Deluxe Digital Qtz. Drive Correc. **$298**

NEW
SRV3200

HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	**Exposures**	**Price**
2415, Ultra-fine B&W, red sens.	36	**$10.95**
SRV3200, fastest of all, color neg	24	**$13.95**
Konica SR-V3200, unhypered	24	**$8.50**
Konica SR400, fine grain color neg	12	**$10.95**
3M 1000, fastest slide film	12	**$12.95**
Fujichrome RD100, fine grain slide	24	**$12.95**
D-19 B&W Developer	1 gal.	**$6.95**

LUMICON means INNOVATION

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550
(415) 447-9570
FAX (415) 447-9589

LUMICON® SKY VECTOR™- *NEW!*

Computer-Controlled Digital Setting Circles, only $498

Incredibly Smart!
thus
Incredibly Easy!

- Digital right ascension readout to 1 minute of R.A.
- Digital decl. readout to 10 arc-min
- 2X higher resolution encoders
- Motor drive ***not required!***
- Polar alignment ***not required!***
- Just sight two stars!

The computer's sophisticated program (over 3000 lines of code) determines **everything** from an initial sighting of just two stars!

- **No need** to enter latitude, longitude, sidereal time, date, etc.
- Works **equally well** for alt-azimuth telescopes like Coulter Odyssey and equatorial mounts like C-8, Meade 2080. The computer automatically knows the difference.
- Uses Epoch 2000.0, 1975.0 or 1950.0 coordinates.
- Light weight, only 2 oz. permits mounting near the eyepiece, if desired. Only 2.6"x2.6"x1".
- 9V Battery lasts many nights.

Sky Vector ™
ON OFF
2137+490
DIM
RA
DEC
MODE
STAR
LUMICON

LUMICON SKY VECTOR™ computer, showing digital readout of coordinates, and easy-to-use controls. Shaft encoders are included (not shown). The coordinates are for Minkowski 1-79, a 13th mag. planetary nebula.

The LUMICON SKY VECTOR™ is a computer-controlled digital setting circle system. It represents a breakthrough in both computer performance and low price. To find an object just move the telescope until the coordinates of the SKY VECTOR™ match those of the object desired.

Each LUMICON SKY VECTOR™ includes one computer with digital readout, two precision digital shaft encoders, connecting cables, & mounting hardware (for most popular telescopes). **Specify telescope.**

LUMICON SKY VECTOR™ for Meade 2080,2120,C-8,C-11, *(Specify)*	**$498**
For Celestron-14 .. **$575.** For any alt-azimuth (Dobsonian) telescope	**$498**
For Coulter Odyssey 8", 10", 13", 17½" *(Specify telescope)*	**$498**
SKY VECTOR KIT. You must supply adapting hardware. For skilled ATM's only	**$459**

Reference catalogues listing coordinates of 1000's of objects

Burnham's *Celestial Handbook,* Vol. I, II, III (Epoch 1950.0)	**$36.85**
The *Revised New General Catalogue* (all NGC and IC, Epoch 1975.0)	**$35.00**
Sky Catalogue 2000.0, Vol. II, doubles, variables, deep-sky objects	**$29.95**

NEW FROM LUMICON

NGC SKY VECTOR™

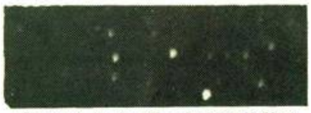
$750

- Advanced version of the LUMICON SKY VECTOR™ with over 8000 object deep-sky memory
- All 7730 revised NGC objects
- All 110 Messier objects
- 365 double & multiple stars
- 25 user defined objects, comets, etc.
- Helps achieve perfect polar alignment (benefits photographers, not needed for viewing)
- For alt-azimuth, equatorial, fork mounts
- 2X higher resolution encoders
- Identifies unknown objects
- Directs telescopes to desired objects by providing real-time angular distance to object
- Provides size, magnitude, coordinates, and visual description of all 8000 objects in memory

PLEASE SPECIFY TELESCOPE TYPE

LUMICON NGC SKY VECTOR™ for Meade 2080/2120	**$750**
NGC SKY VECTOR™ for C-8, C-11	**$750**
NGC SKY VECTOR™ for Celestron-14	**$825**
NGC SKY VECTOR™ for Coulter Odyssey 8, 10, 13, 17½"	**$750**
LUMICON NGC SKY VECTOR™ Kit, you supply hardware	**$709**
LUMICON NGC SKY VECTOR™ Kit for equatorial mounts	**$795**

COMA CORRECTOR



Coma 1 inch off-axis 17½" f/4.5

Same field with LUMICON coma corrector; smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. It threads into LUMICON 2" EASY-GUIDERS for effortless installation. This lens is optimized for f/4.5 and reduces aberrations for f/3.5 to f/5 Newtonians. Off-axis images are much smaller, making off-axis guiding far easier and yielding round pinpoint star images in photos. Since star images are sharp over a full 2¼" circle, you can use medium format cameras in addition to 35mm cameras. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Although designed for photography you may also use this lens to improve image quality in wide-field viewing with low power eyepieces.

LUMICON Coma Corrector/Field Flattener Lens	**$285.00**
LUMICON 2" EASY-GUIDER	**$169.50**
2" EASY-GUIDER (Mamiya 645)	**$199.50**
2" Adapter for Pentax 6x7	**$85.00**
2" Adapter for Hasselblad	**$185.00**
2" Adapter for Bronica SQ-A	**$175.00**
2" Extension for viewing	**$26.00**

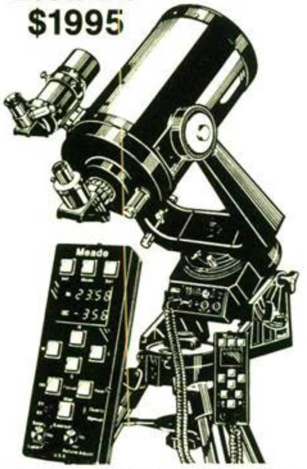
MEADE® TELESCOPES

LUMICON, 2111 Research Dr., #5, Livermore, CA 94550
(415) 447-9570
FAX (415) 447-9589

2080/LX6 8" f/6 .. $1995
2120/LX6 10" f/6 . $2499

Digital readout system for 2080/2120/LX6	**$399**
8200 object memory CAT computer	**$999**

NEW
2080/LX6
$1995



Meade Model 2080/LX6: The most advanced Schmidt-Cassegrain telescope available today. The hand-held electronic command center controls all telescope functions, and has digital coordinate readout available as an option. The f/6.3 optics yield 2½x shorter exposures in astrophotography.

MEADE SERIES 4000 EYEPIECES

Super Plossl: 6.4mm, 9.7mm, 12.4mm **$89**
15mm, 20mm, 26mm **$89;** 32mm **$109**
Super Wide-angle: 13.8mm **$129,** 18mm **$135,** 24.5mm **$149,** 32mm (2") **$219**
Ultra Wide-angle: 4.7mm **$149,** 6.7mm **$179,** 8.8mm **$209,** 14mm **$249**

SCHMIDT-CASSEGRAIN

2080 Original w/tripod, MCOG	**$1089**
2080 Original 8" f/10 w/tripod	**$999**
2080/LX3, 8" f/10 w/MCOG	**$1450**
2080/LX5, 8" f/10 w/MCOG	**$1650**
2120/LX5, 10" f/10 w/MCOG	**$2095**
2120/LX3, 10" f/10 w/MCOG	**$1895**
2045D 4" f/10 w/motor drive	**$695**
#39 declination motor for LX5	**$109**
#38 (LX3) or #38A (2045) dec. mtr.	**$99**
Dew shield - essential! 8" **$65;** 10"	**$98**
LUMICON EASY-GUIDER for 2080	**$225**
EASY-GUIDER (f/4-f/10) for 2120	**$395**
CAT command control, 8200 objects	**$999**

SCHMIDT-NEWTONIAN

MTS-SN6, 6" f/5, #788 drive	**$649**
MTS-SN6 w/drive, MCOG	**$698**
MTS-SN8, 8" f/4 w/drive, MCOG	**$795**
MTS-SN8, 8" f/4 w/LX3 drive, MCOG	**$1048**
#36 LX3 hand cntrl. & #38 dec. motor	**$189**

NEWTONIAN

Model 826C 8" f/6 w/motor, 2" focuser	**$975**
Model DS-10A, 10" f/4.5 w/mtr., 2" focus.	**$975**
Model DS-16A, 16" f/4.5 w/motor, 2" focuser	**$1975**
Model DS-16A w/Sealmaster ball bearings for photography	**$2195**
8X50mm finderscope w/brackets for DS-10 or DS-16	**$109**

LUMICON ACCESSORIES

1.8x MULTIPLIER LENS

1.8x Multiplier Lens

The computer-designed LUMICON 2" Multiplier/Field Flattener multiplies the image scale in photography by 1.8x (f/4.5 becomes f/8). Use it with any LUMICON 2" EASY-GUIDER. Guide-stars also become much sharper to make guiding easier. This lens is optimized for f/4.5, but will work well with any optical system. It may also be used visually as a highly corrected 2" Barlow lens.

LUMICON 1.8x multiplier lens	**$235.00**

NEW! LOW PROFILE HELICAL FOCUSERS

FROM
$49.50

LUMICON® LOW PROFILE FOCUSERS

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

Select your desired base-plate shape! Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD, SUPER-FINDER base plate.

LUMICON 1¼" Helical Focuser	**$49.50**
LUMICON 2" Helical Focuser	**$59.50**
LUMICON Non-rotating Helical Focuser	**$89.50**
2" rack & pinion low profile focuser	**$129.00**
3 handles for non-rotating focuser	**$12.95**
2"/1¼" adapter w/48mm filter threads	**$20.00**
2" LUMICON EASY-GUIDER	**$169.50**

LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat. The deluxe SUPER-FINDER uses an 80mm, F=500mm air spaced achromat.

1¼" 50mm Finderscope **$59.50**, right-angle	**$89.50**
1¼" straight-thru 80mm SUPER-FINDER	**$169**
1¼" right-angle version, w/star diagonal	**$195**
1¼" Deluxe right-angle Super-Finder*	**$279**
25mm Cross-hair 1¼" eyepiece (12X)	**$29**
*1¼" Star Diag. **$32**, 2" Star Diag., silver,	**$159**
1¼" Amici Prism diag. for correct left-right views	**$69.50**

2" ADAPTERS MEADE, CELESTRON TELESCOPES

These adapters convert refractors and Schmidt-Cassegrain telescopes for 2" operation. They allow use of 2" accessories, such as the LUMICON 2" EASY-GUIDER for photography. They also allow use of 2" eyepieces and/or 2" star diagonal for viewing.

2" adapter for C-8, Meade 2080, etc.	**$26.00**
2" adapter for C-80, C-100 refractor	**$39.50**
2" adapter for C-70, C-80F, C-90F, C-100F	**$39.50**
2" Accessory adapter for Comet Catcher*, C-6*, Meade 310, 320 refractor	**$30.00**
2" adapter for Takahashi E-130, 160	**$59.50**

by these jets is a particular kind of prodigious non-thermal energy called synchrotron radiation, which is caused by electrons being accelerated around magnetic field lines.

Many astronomers believe near-collisions between galaxies may have occurred more frequently billions of years ago when the universe was smaller and galaxies were closer to each other. This would explain why most quasars are seen at a preferential distance (about 12 billion light-years) yet none are nearby today.

BINARY QUASAR system PHL 1222 may be the result of two galaxies passing near enough to each other to fuel their respective black holes. Photo by Georges Meylan (STScI), George Djorgovski and Nick Weir (Caltech), and Peter Shaver (ESO).

DUST CLOUD DISCOVERED AROUND FOMALHAUT

Astronomers have found a cool dust cloud orbiting the nearby star Fomalhaut in the constellation Pisces Austrinus. The dimensions and infrared emission of the cloud suggest to researchers that it may be composed of material left over from the formation of a solar system.

Dan Lester, Paul Harvey, Beverly Smith, and Cecilia Colome of the University of Texas reported on their finding at the January meeting of the American Astronomical Society in Arlington, Virginia. The observations were made in November 1988 using a 0.9-meter telescope mounted aboard NASA's Kuiper Airborne Observatory. The telescope utilized a sensitive array of infrared detectors provided by Frank Low of the Steward Observatory in Tucson, Arizona.

The infrared detectors allowed the astronomers to see the cloud directly. They derived an angular diameter of about 45 arcseconds, which, at Fomalhaut's distance (22 light-years) translates into a diameter of about 300 astronomical units. Although the cloud is several times larger than our own solar system (the orbit of Pluto is 80 AUs across), it has a size that is similar to that of the debris cloud from which our solar system is believed to have formed.

Fomalhaut is an A-type star that is twice as massive as the Sun and fourteen times as luminous. Several years ago researchers studying data from the Infrared Astronomical Satellite (IRAS) all-sky survey noticed that Fomalhaut emits much more infrared light than would be expected from an otherwise normal star. It was suggested that the excess infrared emission is from orbiting dust grains heated by the star.

The new observations give additional weight to the idea that Fomalhaut's dust cloud is composed of fairly large dust grains and perhaps even larger objects. The University of Texas astronomers base their hypothesis on a circumstellar model that predicts that perfectly absorbing and re-emitting grains, when placed at a distance of about 150 AUs from a star with the brightness of Fomalhaut, should be heated to exactly the temperature that this dust cloud appears to have (50 kelvins).

The astronomers report that the grains they detected are larger than about 100 microns, roughly one-tenth of a millimeter across. According to Lester, grains this size, though small, are capable of colliding and making rocks and boulders. In fact, the data do not exclude the possible presence of larger bodies such as planets. "Our observations just weren't sensitive to them," Lester said.

More observations are planned from the Kuiper Airborne Observatory this May. "This is just the beginning of what we hope to do," said Lester. "With the additional data that we will try to get this spring, we should be able to probe the inner structure of this cloud. If a solar system as we know it really did form around Fomalhaut, the dust cloud ought to look like a donut with a hole in the center where the planets have condensed." The fact that the cloud is so cold had suggested to IRAS researchers that there is little solid material close to the star. The observing team will use special image-enhancing techniques to search for this hole.

BAR OF STARS FOUND IN MILKY WAY

It looks like astronomers are going to have to revise our galaxy's self image. Once thought to have an ordinary spherical bulge at its center like the Andromeda or Whirlpool galaxies, researchers have now found compelling evidence that the inner region of the Milky Way is shaped like a football.

The finding, presented at the January meeting of the American Astronomical Society in Arlington, Virginia, is based on new analyses of data taken from previous 21-centimeter radio observations of the motions of interstellar atomic hydrogen gas in both the outer and inner regions of the Milky Way. These observations, taken 15 years ago, had shown that most of the gas in the outer region of the Galaxy appears to be moving inward toward the Sun, rather than orbiting in circles about the galactic center as most astronomers thought. Furthermore, these same observations showed that the gas between the Sun and the galactic center nearly matches the Sun's orbital velocity.

At the time it was believed that the Sun orbited the Galaxy in a circular orbit. Thus, in trying to make sense of the observations, astronomers assumed that for some reason the interstellar gas in the outer Galaxy was moving in toward the Sun. This view seemed especially reasonable since, according to the motions of the inner gas, the Sun didn't appear to be moving away from the galactic center.

But that was the old view of the Galaxy. Using mini-supercomputers, Leo Blitz of the University of Maryland and David Spergel of Princeton University have developed a dynamical model that reconciles these two observations. Their results show that it is the Sun that is moving toward the outer gas, not the reverse. Moreover, their model requires that the Sun orbit the galactic center on a noticeable ellipse and that the interior gas also move along elliptical, not circular, orbits.

To gravitationally induce these observed orbital motions, Blitz and Spergel's dynamical model specifies that the matter in the Galaxy's bulge, which is mostly stars, be an oval or bar-shape. The existence of such an "oval distortion" in the Milky Way would place our galaxy in the class of barred spirals, galaxies with spiral arms that curve away from the ends of a barlike section of stars running through the center of the galaxy. Blitz said that although the bar

TUTHILL, YOUR ASTRONOMICAL FRIEND ASKS:

Do you wish to discuss the purchase of the correct telescope for YOU, or need advice on optics of any kind?

Call us TOLL FREE 1-800-223-1063, and talk in detail with amateur astronomers who have made telescopes, ground mirrors and lenses, and know optics. They can give you unbiased authoritative information.

• • • •

Would you like to sit in your warm living room and view the sky in comfort on your TV? — Let a group of people see the Sun, Moon, Planets, and other celestial objects? You need our **NEW 0.02 lux STAR TRAP CCD VIDEO CAMERA!**

• • • •

Are you using your scope only at night and missing the pleasure of seeing faint Sun spots and surface mottling? You need our **SOLAR SKREEN**! Send a large 8x11 stamped envelope for a FREE sample.

• • • •

Are you frustrated with dew on your corrector lens? You need our thirsty, heatable **NO-DU CAP**!

• • • •

Are you wasting valuable observing time leveling your tripod? Are you having trouble finding the pole quickly? You need our **PRECISION POLAR AXIS FINDER**! It lets you do the job accurately in less than two minutes.

• • • •

Are you looking for a low cost accurate Digital Readout which does not use belts, and permits you to store the scope in the trunk without removing the encoders? You need our **CELESTIAL NAVIGATOR MARK V**!

• • • •

Are you tired of carrying reference books and a flashlight? Are you looking for a hand-held computer that gives you descriptions, magnitudes, and exact coordinates of all Messier Objects, some reference stars, and all 7800 NGC objects? You need our **SMART CHART**!

• • • •

Are you tired of using a finder that gives reversed images? You need our 50mm and 80mm **ULTIMATE FINDERS** for a correct image!

• • • •

Would you like a Quartz Drive Corrector that would have its own internal rechargeable batteries? You need our **#1 STAR TRAP POWER MODULE**! Would you like to convert your SCT to cordless operation? You need our **#2 STAR TRAP POWER MODULE**!

• • • •

Do you wish your SCT had a vernier adjustment on the manual RA motion? You need our **MICRO DRIVE** - ten times finer control.

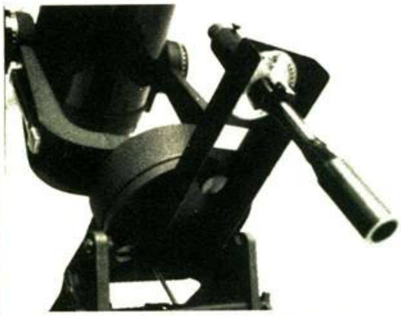
• • • •

Are you suffering from misaligned SCT optics because you don't think you could properly collimate your scope? You need our step by step **INSTRUCTIONAL VIDEO TAPES** in NTSC or PAL!

• • • •

Do you need a good cleaning kit, great **LOW COST PLOSSL EYEPIECES**, light pollution filters, books, parts, or someone to clean, collimate, and adjust your SCT? Call us TOLL FREE, 1-800-223-1063!

SOLAR SKREEN®



PRECISION POLAR AXIS FINDER®

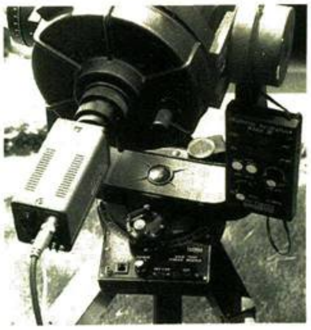
CELESTIAL NAVIGATOR®
MARK V
DEC
RA
SLOW FAST
RA-ADJ
DEC-ADJ
OFF-ON
BRIGHTNESS POWER
TUTHILL

CELESTIAL NAVIGATOR® DIGITAL RA/DEC

SUPER, HELICAL FOCUSING 50mm AND GIANT AMICI PRISM 80mm FINDERS

TUTHILL
STAR TRAP POWER MODULE
QUARTZ LOCKED
POWER INCH
OFF-ON
12V

MICRO DRIVE

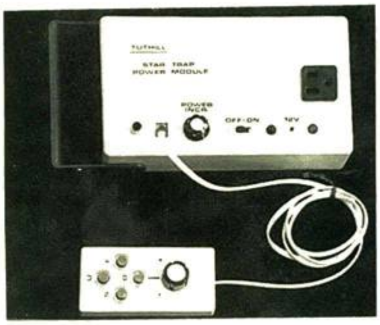


NEW STAR TRAP® TV CCD CAMERA SYSTEM

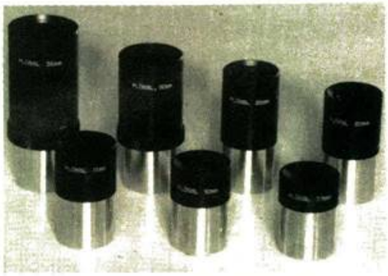
NO-DU CAPS®

UP
LEFT
RIGHT
DOWN
SMART CHART™
Research Instruments

SMART CHART®



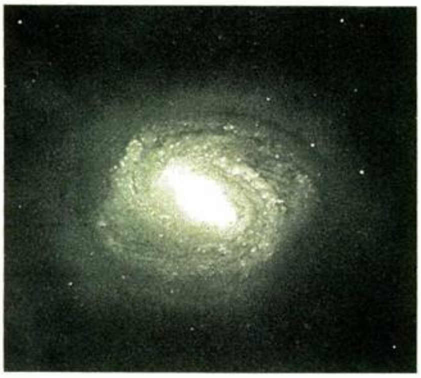
STAR TRAP® PORTABLE POWER SUPPLY DRIVE CORRECTOR



TUTHILL PLOSSL EYEPIECES

Send an 8" x 11" SASE for FREE information on Celestron, Meade, Questar, TeleVue and Odyssey Scopes; Willmann-Bell Publications, Lumicon, Clave and other fine products. Time payment, COD, VISA and MC. For info or orders CALL TOLL FREE 1-800-223-1063. In NJ (201) 232-1786. FAX (201) 232-3804

Roger W. Tuthill, Inc., Box 1086-A, Mountainside, NJ 07092



DOES OUR GALAXY LOOK LIKE THIS? Astronomers think the Milky Way's inner region may be oval, similar to this galaxy, M58. Photo from the *Hubble Atlas of Galaxies*, the Observatories of the Carnegie Institution of Washington.

is not as pronounced as those in many classic barred spirals, it extends outward to a distance comparable to that of the Sun's distance from the center.

Blitz and Spergel believe that their model's description of the Sun's elliptical orbit around the center of the Galaxy also explains why dense molecular clouds moving around the core of the Milky Way, and thus unaffected by the oval distortion, show a motion away from the Sun: The Sun is moving *away* from the galactic center. According to their model, the Sun is now about halfway between its point of closest approach to the galactic center (perigalacticon) and the point of its farthest distance (apogalacticon). The Sun will reach apogalacticon in about 25 million years. The difference in distance between apogalacticon and perigalacticon is about 1,500 light-years.

Blitz said that bars have important dynamical effects on the material in the disk of a galaxy, such as regulating how stars form in the disk and determining the appearance and persistence of the spiral arms themselves. He also added that bars are like "footprints of an earlier epoch" in that the size and shape of the Milky Way bar, plus how fast it's spinning, point to conditions that existed at the time the Galaxy formed.

"Astronomical objects can be viewed as having memory," said Blitz. "On the small scale, stars for example, matter has little memory. But on the large scale, such as with galaxies, matter has tremendous memory. A galaxy can remember its origins and subsequent evolution." By studying the barlike distribution of matter in the inner Milky Way, Blitz said, astronomers might be able to "read" its memory of former conditions and discover new insights into our galaxy's history.

LUNAR TRANSIENT PHENOMENA MECHANISM DISCOVERED?

For centuries lunar observers have reported seeing occasional flashes of light or brightenings in small areas on the Moon. The flashes often appear reddish or bluish and usually turn on and off rapidly. For lack of a better term these elusive events are called lunar transient phenomena, or LTPs for short. Although many theories have been proposed to account for them, no one knows what causes LTPs. Moreover, given the scarcity of hard observational evidence, some planetary scientists have remained steadfastly skeptical that they exist at all.

Now Richard R. Zito of the Lockheed Missiles and Space Company, writing in the December 1989 issue of *Icarus*, has proposed a mechanism that would account for many LTPs. Noting that lights have been seen during some terrestrial earthquakes, he suggests that brief flashes of light may be emitted under certain conditions when rocks are suddenly fractured. In the case of LTPs, Zito notes that lunar rocks are known to contain inert gases such as helium and argon produced by the decay of radioactive elements. When a lunar rock is fractured, some gas escapes along with energetic electrons. According to Zito's theory, as the electrons speed through the gas, they could briefly charge it to fluorescence.

You can simulate his mechanism yourself by crunching a Wint-O-Green Life Saver in the dark, although the analogy isn't exact because the Life Savers "turn on" when the molecules that provide the wintergreen flavor are physically distorted. Smashing a sugar cube with a hammer produces a similar effect when seen in the dark because sugar molecules behave the same way.

Zito says that his mechanism would work even without a moonquake. He thinks that ordinary thermal stresses (produced as Moon rocks heat up and cool off during the lunar day) could also provide enough energy to release the gas and electrons.

LTPs are notoriously elusive, so Zito suggests that there might be another way to test his theory besides prolonged bouts of staring into a telescope eyepiece. A rock surface that has just been fractured will minutely rearrange its crystal lattice. In the process it will emit a short pulse of radio energy with frequencies that fall into the band between 900 and 5000 hertz. Although signals of these frequencies cannot penetrate Earth's ionosphere, Zito believes they could be detected relatively easily from a low-altitude lunar orbiting probe.

Space News

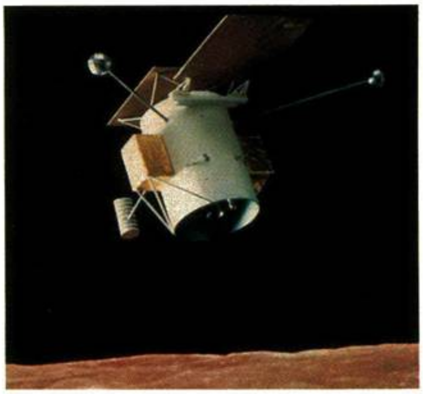
A PRIVATE RETURN TO THE MOON?

Before America establishes a base on the Moon, a lot more has to be learned about Earth's nearest neighbor. Specifically, NASA needs to locate water and other volatile chemicals that may lie waiting on the Moon. Not only would these materials help make a lunar base partially self-sustaining, but they would also bring down the cost of lunar exploration.

With that in mind, the Space Studies Institute, a privately funded space research organization based in Princeton, New Jersey, has decided to build a robotic space probe — the Lunar Prospector — to map deposits of lunar resources. The Lunar Prospector's primary mission is to find ice that can be used at a lunar base. The water can also be separated into hydrogen and oxygen, which can be used as rocket fuel. According to Institute executive vice president Gregg Maryniak, "Effectively exploring and settling the solar system will require the use of resources already in space."

As spacecraft go, the Prospector is a pretty small affair. Weighing in at a just over 500 pounds, the cylindrical craft will measure 4.6 feet in diameter and 2.9 feet tall. There will be several antennas extending radially out from the craft. The Prospector will be placed in a polar orbit a mere 60 miles above the lunar surface.

Design work for the Lunar Prospector is being performed by Omni Systems Incorporated, an aerospace company in



LAUNCHED IN 1992, the Space Studies Institute's "Lunar Prospector" spacecraft will search for ice deposits near the lunar poles.

Agoura, California. Omni Systems will have detailed designs for the space probe completed by this summer.

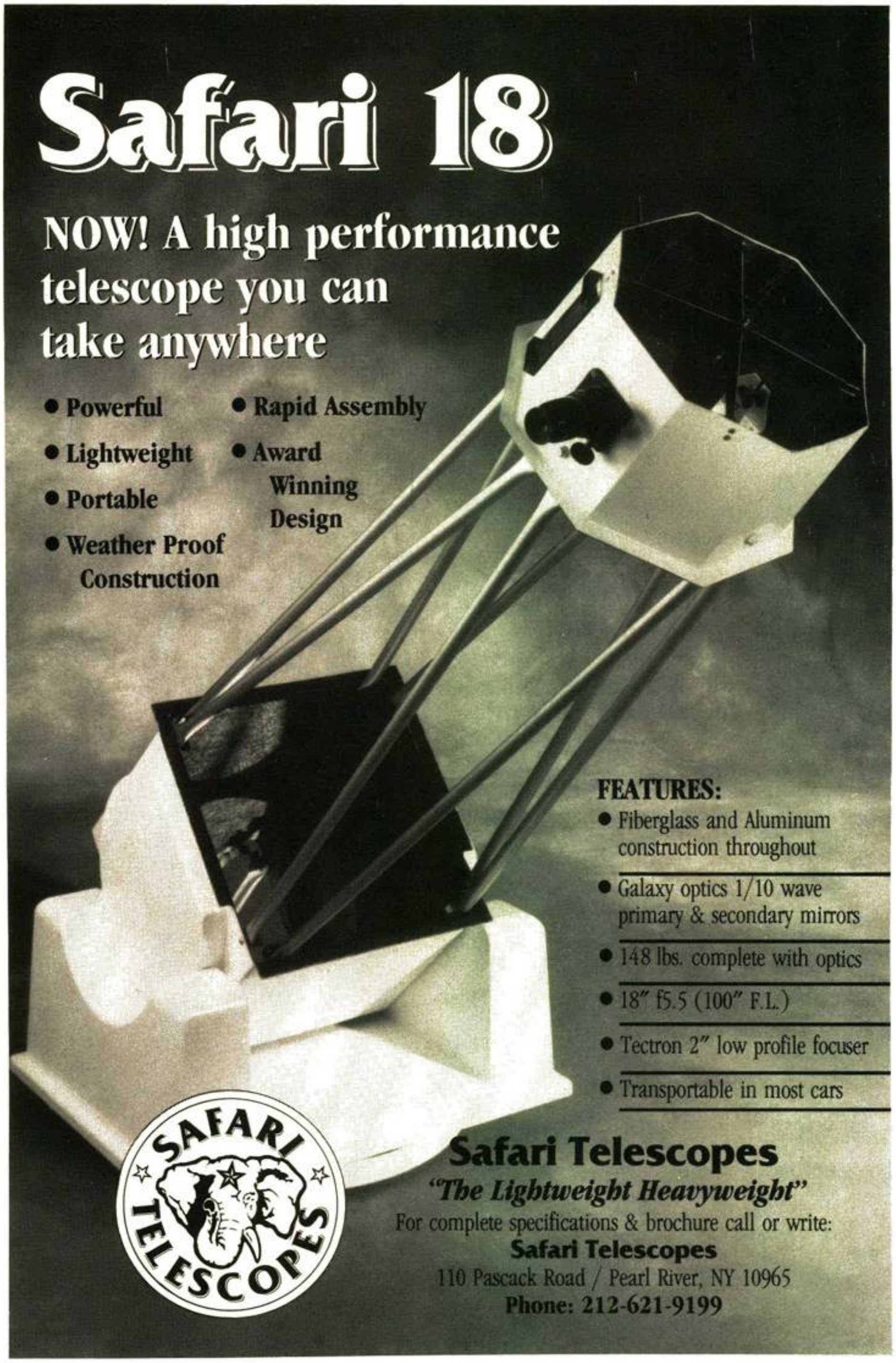
With the design work under way, the Space Studies Institute is working to overcome a major hurdle still facing the project — money. Maryniak estimates that it will take $5 million to construct the Lunar Prospector. The Institute is actively seeking funds from aerospace companies and "organizations that typically fund expeditions and science and space projects," Maryniak said.

The Space Studies Institute also has to decide how the Lunar Prospector will be launched. Because the Lunar Prospector is so small and lightweight, Maryniak expects that the probe can be piggybacked on a launch vehicle along with a larger satellite. This will help keep the launch cost as low as possible.

The Lunar Prospector will carry five instruments. A gamma-ray spectrometer will provide a chemical map of the lunar surface and will look for caches of ice that may exist in permanently shadowed craters at the lunar poles. The lunar magnetic field will be mapped by two instruments, a magnetometer and electron reflectometer. The alpha-particle spectrometer will locate and measure the distribution of radon gas released by the Moon. A simple radio on the Prospector will be used to map the lunar gravity field. This will help engineers and scientists predict orbital movements with the accuracy needed for routine lunar orbital operations.

"NASA's reaction to the project has been very positive," Maryniak said. "The space agency has even agreed to provide the gamma-ray spectrometer for the mission. The only stipulation is that the information gathered by the instrument be made available to the public."

Maryniak hopes the Lunar Prospector will be ready to fly by 1992. The timing



Safari 18

NOW! A high performance telescope you can take anywhere

- Powerful
- Lightweight
- Portable
- Weather Proof Construction
- Rapid Assembly
- Award Winning Design

FEATURES:

- Fiberglass and Aluminum construction throughout
- Galaxy optics 1/10 wave primary & secondary mirrors
- 148 lbs. complete with optics
- 18" f5.5 (100" F.L.)
- Tectron 2" low profile focuser
- Transportable in most cars

SAFARI TELESCOPES

Safari Telescopes

"The Lightweight Heavyweight"

For complete specifications & brochure call or write:

Safari Telescopes
110 Pascack Road / Pearl River, NY 10965
Phone: 212-621-9199

Travel to the moons of Jupiter with Galileo!

The Space Shuttle *Atlantis* gives the Galileo Jupiter probe a lift to its destination in this colorfully embroidered patch from NASA's official supplier. In the shape of a triangle, this detailed patch shows *Atlantis* carrying the probe on its back with Jupiter and the sun in the distance. Great on jackets, caps or for display! Order this collectible patch today! #35082.

STS 34 4"x 4-1/2" $5.49

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., P.O. Box 1612, Waukesha, WI 53187-1612. Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3.00). Wisconsin residents add 5% sales tax.

WILLIAMS
McCULLEY
LUCID
BAKER
CHANG-DIAZ

of the launch could prove most useful for NASA's plans for a lunar base. By the mid-1990s the president is expected to make concrete decisions about the future of America's manned exploration of the solar system. Information gathered by the Lunar Prospector will help determine where the United States will establish its first lunar outposts. — *Robert G. Nichols*

JAPAN LAUNCHES FIRST LUNAR MISSION

As private industry in America plans for future Moon exploration (see story above), Japan became the third country to launch an unmanned rocket to the Moon. On January 24 the Japanese government sent a 93-foot-tall Muses-A rocket carrying two satellites aloft on the first lunar mission since August 1976. The launch occurred from the Kagoshima Space Center on the island of Kyushu in southern Japan.

The satellites were scheduled to make a rendezvous with the Moon's gravitational field on March 18. There the larger of the two satellites will fall into an elliptical orbit that will carry it past the Moon, toward Earth, and back again toward the Moon. The smaller satellite will gravitate into a close lunar orbit and will perform a series of instrument tests designed to help Japanese scientists plan future Moon missions.

The satellites are intended to help Japan play catch up in the area of space operations. The Japanese space program has developed at a glacial pace and has not been heavily funded. (The Japanese space budget is $1.1 billion, less than one-tenth of NASA's budget.)

Despite showing only weak flirtation with space exploration in the past, Japan intends to develop a major space presence in the coming decades. Among Japan's goals in space are developing its H2 rocket, a Titan-class vehicle capable of launching two-ton satellites into Earth orbit, and a module for Space Station *Freedom*.

Launching its first satellite beyond Earth orbit is an important milestone for Japan, and one that may establish confidence toward developing activity in manned space exploration. Involvement by high-tech firms should make the leap from simple projects to more complex ones easier. The Muses A rocket was built by the Nissan Corporation. NEC, Mitsubishi, and Toshiba are all playing active roles in developing satellites.

Amateur News

AMATEUR SETI PROJECT IN TROUBLE

Bob Stephens operates the world's only amateur-run project to search for radio signals from alien civilizations. Called Project TARGET (Telescope Antenna for Research into Galactic Extraterrestrial Transmissions), Stephens' program has earned the respect of his professional colleagues around the world. However, Project TARGET is in trouble. Stephens has access to the right kind of antenna, but to continue his work Stephens needs $40,000 for a state-of-the-art radio receiver. In the last few months searching for a donor has been more important than searching for ETs.

But financial crises aren't new to Stephens. Driving a beat-up 1970 Chevelle and subsisting on peanut butter sandwiches, Stephens spent three years in Canada's Northwest Territories. There Stephens converted a pair of rusting DEW-line antennas into radio telescopes.

With this unlikely setup Stephens began his SETI program in 1985. The Search for Extraterrestrial Intelligence (SETI), once considered a crackpot idea, has now gained acceptance worldwide. Nevertheless, organized programs work on shoestring budgets. A $4,000 grant from the Planetary Society helped Stephens for a while, but the financial crunch eventually came. In 1988, the landlord literally moved in, evicting Stephens for not making his lease payments on the DEW-line antenna site.

Still, Stephens didn't give up. He packed his racks of electronics in an old school bus and headed south. In 1989 he secured a position in Ontario as an operator at the Algonquin Radio Observatory's solar program. The real prize was the chance to work with a mothballed 60-foot antenna at the ARO site.

Stephens has the antenna but needs a device called a multi-channel spectrometer. It's a fancy receiver that can listen to 10 million channels at once — like the ultimate police scanner. Stephens has been offered a prototype from Stanford University for $40,000.

With this receiver Project TARGET would have equipment that equals the sensitivity of other SETI programs. In fact, claims Stephens, his set-up would have a major technical advantage over other SETI antennas since he could listen over a band of frequencies some fifteen times wider than anyone else's.

He's even more excited about the prospect of attaching such a spectrometer to the focus of the 46-meter main dish at Algonquin. Such a combination would have six times the sensitivity of any existing SETI antenna.

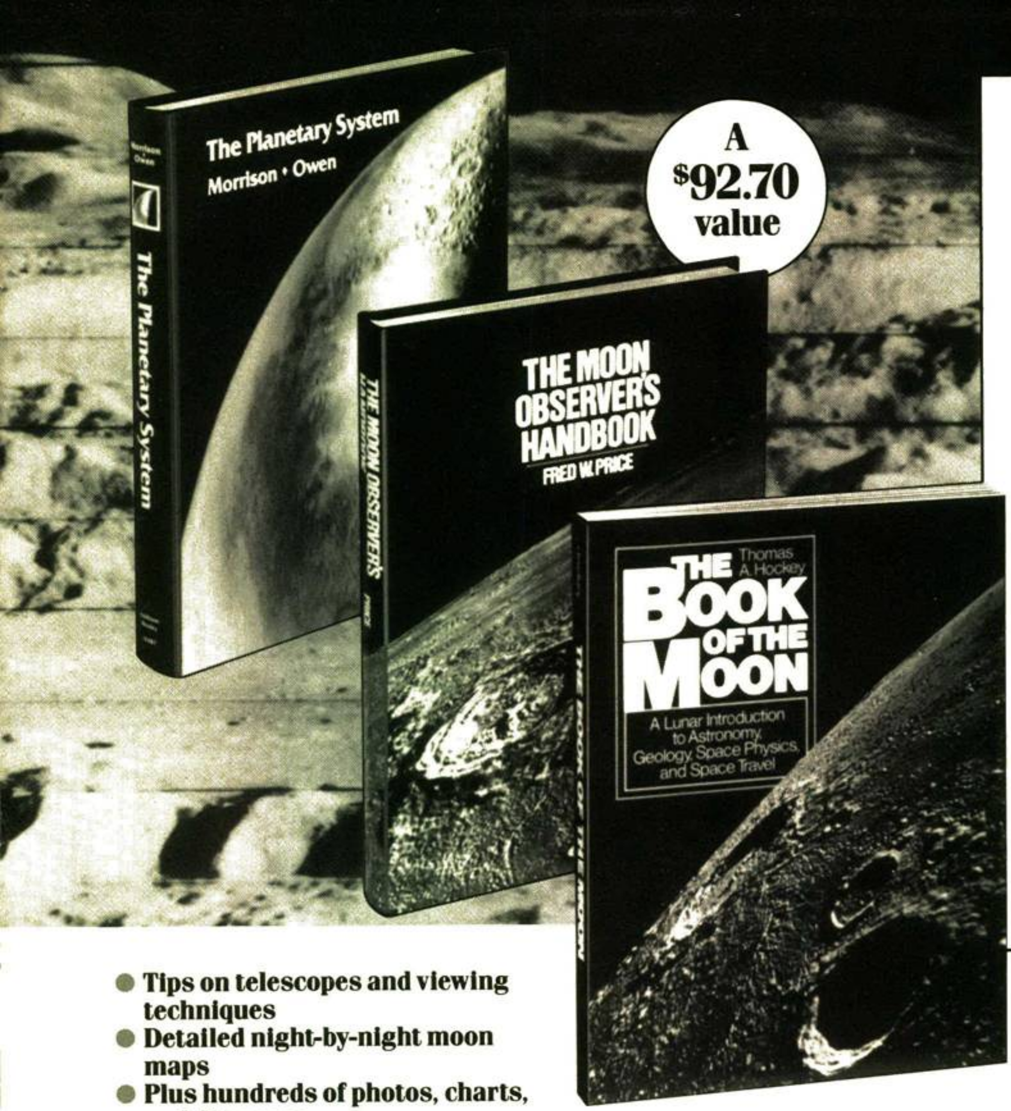
That's the future Stephens envisions for Project TARGET. But without some immediate funding, his privately run SETI program is in jeopardy. He may have to give up the Algonquin site, though it's doubtful Bob Stephens will give up his commitment to SETI. For more information about Project TARGET, write to Bob Stephens, c/o The Algonquin Radio Observatory, Lake Traverse, Ontario, Canada K0A 2L0.

SYMPOSIUM PLANNED FOR 1991 ECLIPSE

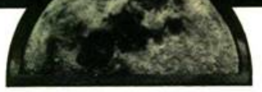
An international symposium of amateur and professional astronomers has been scheduled for July 8-12, 1991, in La Paz, Baja California, to coincide with the 1991 total solar eclipse. Organizer Stephen J. Edberg of the Jet Propulsion Laboratory calls the meeting "an extraordinary chance for experienced amateur astronomers and professionals to come together and participate in seminars, lectures, poster sessions, and field trips." Edberg expects over three hundred participants from many countries; the paper sessions will be in English and Spanish.

The symposium will emphasize the role amateurs play in scientific research, with the intent of fostering increased cooperation and activity between amateurs and professionals. Among those already scheduled to make presentations are John Westfall of the Association of Lunar and Planetary Observers, David Crawford of the International Dark-Sky Association, Alberto Levy of the Socieded Astronomica de Mexico, and Charlie Oostdyk of the Monterey Institute for Research in Astronomy.

For further information on the symposium, contact the Corporation for Research Amateur Astronomy, P. O. Box 16542, San Francisco, CA 94116. □


The Planetary System
Morrison • Owen
THE MOON OBSERVER'S HANDBOOK
FRED W. PRICE
Thomas A. Hockey
THE BOOK OF THE MOON
A Lunar Introduction to Astronomy, Geology, Space Physics, and Space Travel

A $92.70 value



Take

The Moon Observer's Library *for only*

$2.95!

when you join the

ASTRONOMY BOOK CLUB

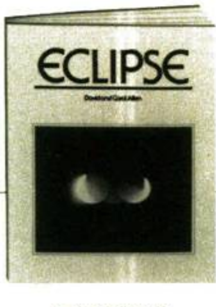
You simply agree to buy three more books—at significant savings—within the next 12 months.

- Tips on telescopes and viewing techniques
- Detailed night-by-night moon maps
- Plus hundreds of photos, charts, and diagrams

THE MOON OBSERVER'S HANDBOOK
Fred W. Price
Despite the fact that the moon has already been photographed up close and walked on by man, many opportunities for significant lunar discovery still remain for the dedicated amateur astronomer. And *The Moon Observer's Handbook* offers the best advice on exactly where and how to look for little-known formations, uncharted territories and controversial TLP's (transient lunar phenomena never explained by orbiting spacecraft). With just a modest telescope and the author's night-by-night surface maps you can actually help map the moon's "last frontier."
Publisher's price: $34.50

THE BOOK OF THE MOON
A Lunar Introduction to Astronomy, Geology, Space Physics, and Space Travel
Thomas A. Hockey
This complete lunar guide offers an intriguing overview of our natural satellite from the dawn of time to the day Neil Armstrong set foot on its surface . . . to the return to the moon in the 1990's and beyond. With hundreds of photographs and a wealth of historical and scientific fact, *The Book of the Moon* contains fascinating insights into—
• lunar mythology • scenarios for the moon's origin • the lunar landscape • the complete story of the Gemini and Apollo space programs • recent findings by American and Soviet lunar scientists • plus plans for future colonization.
Softcover. **Publisher's price: $14.95**

THE PLANETARY SYSTEM
David Morrison and Tobias Owen
"A judicious and comprehensive selection of topics, clear qualitative explanations and instructive and lovely illustrations."—*Carl Sagan*
This outstanding introduction to the evolution of our entire solar system provides an excellent context for understanding our own moon. In addition to special sections on lunar topology, exploration and the three current theories on the moon's origins (daughter, sister, capture), *The Planetary System* features an extensive comparative study of the Moon and Mercury to suggest solutions to lingering puzzles.
Publisher's price: $43.25



FREE!
ECLIPSE *by David and Carol Allen*
Photographic tips and observational techniques. **Publisher's price: $12.95**

THE ASTRONOMY BOOK CLUB is operated exclusively for astronomy enthusiasts. It offers only the finest astronomy books available and offers members the opportunity to purchase them conveniently and inexpensively.

MEMBERSHIP BENEFITS • In addition to getting The Moon Observer's Library for only $2.95 when you join, you keep saving substantially on the books you buy. • Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of 60% off the publishers' prices. • At 3–4 week intervals (15 times per year), you will receive the Astronomy Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. • In addition, up to two times a year, you may receive offers of Special Selections which will be made available to a group of select members. • If you want the Main Selection, do nothing, and it will be sent to you automatically. • If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. • You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

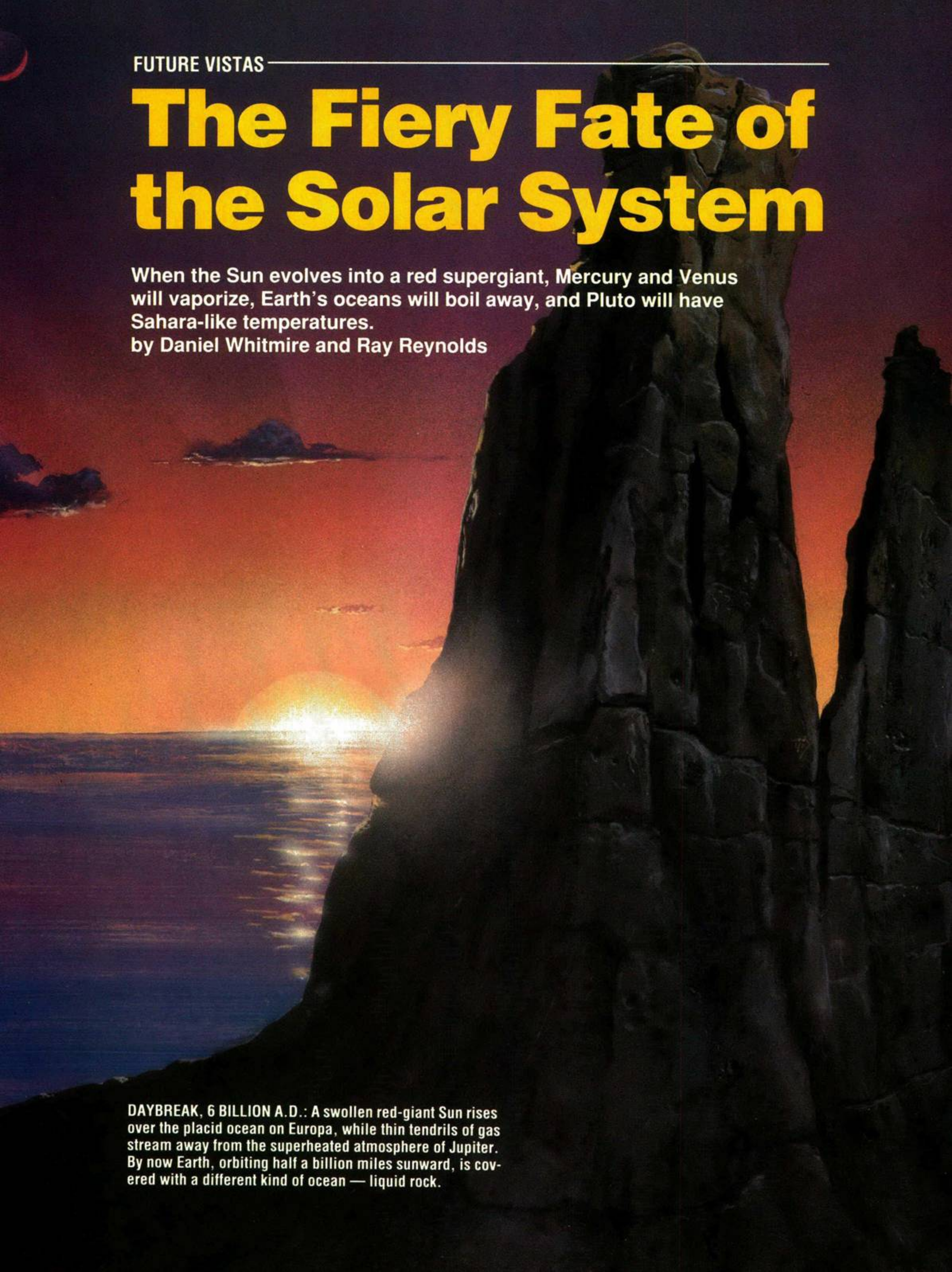
If reply card is missing, please write to Astronomy Book Club, Dept. L-CN6-00007, Delran, NJ 08075, for membership information and an application. **Astronomy 4/90**

FUTURE VISTAS

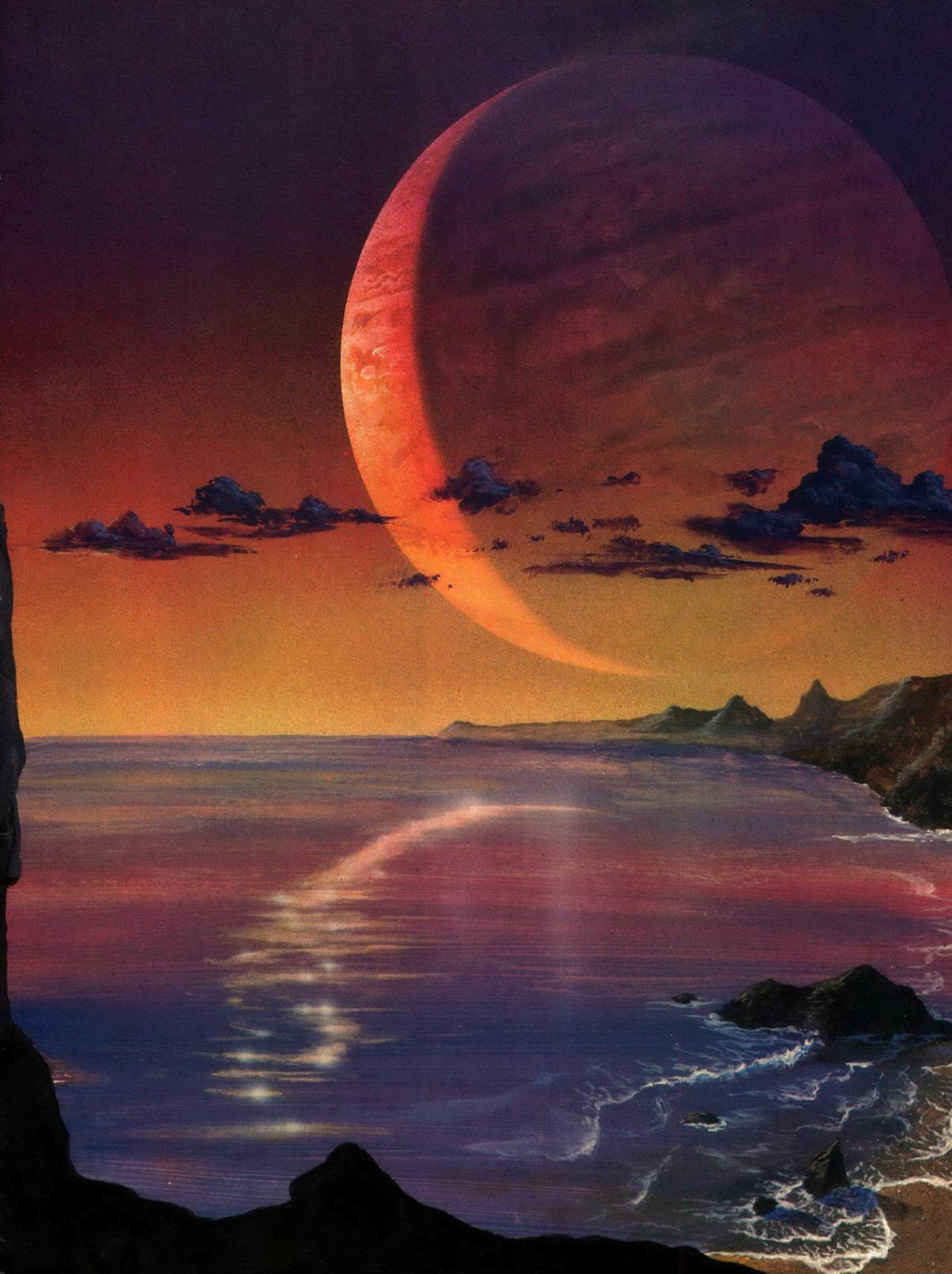
The Fiery Fate of the Solar System

When the Sun evolves into a red supergiant, Mercury and Venus will vaporize, Earth's oceans will boil away, and Pluto will have Sahara-like temperatures.

by Daniel Whitmire and Ray Reynolds



DAYBREAK, 6 BILLION A.D.: A swollen red-giant Sun rises over the placid ocean on Europa, while thin tendrils of gas stream away from the superheated atmosphere of Jupiter. By now Earth, orbiting half a billion miles sunward, is covered with a different kind of ocean — liquid rock.



Major changes are in store for the planets as the Sun evolves over the next few billion years. Slowly at first but at an ever faster rate, the Sun's luminosity will grow to nearly ten thousand times its current brightness and the solar surface will reach out as far as Earth's present orbit. As the Sun brightens the entire solar system will feel the heat: lofty mountains will soften and flow, icy moons will thaw, and thick atmospheres will appear on worlds where no winds have blown for billions of years.

About 4.6 billion years ago, the Sun and planets formed in the collapse of an interstellar cloud of gas and dust. The newborn Sun soon settled down onto the main sequence, the name astrophysicists give to the longest active phase in a star's life. During this period, the Sun is powered by thermonuclear reactions in its core that fuse hydrogen into helium. The heat from these reactions causes the Sun to shine and maintains a pressure to support the star against the inward pull of its own gravity.

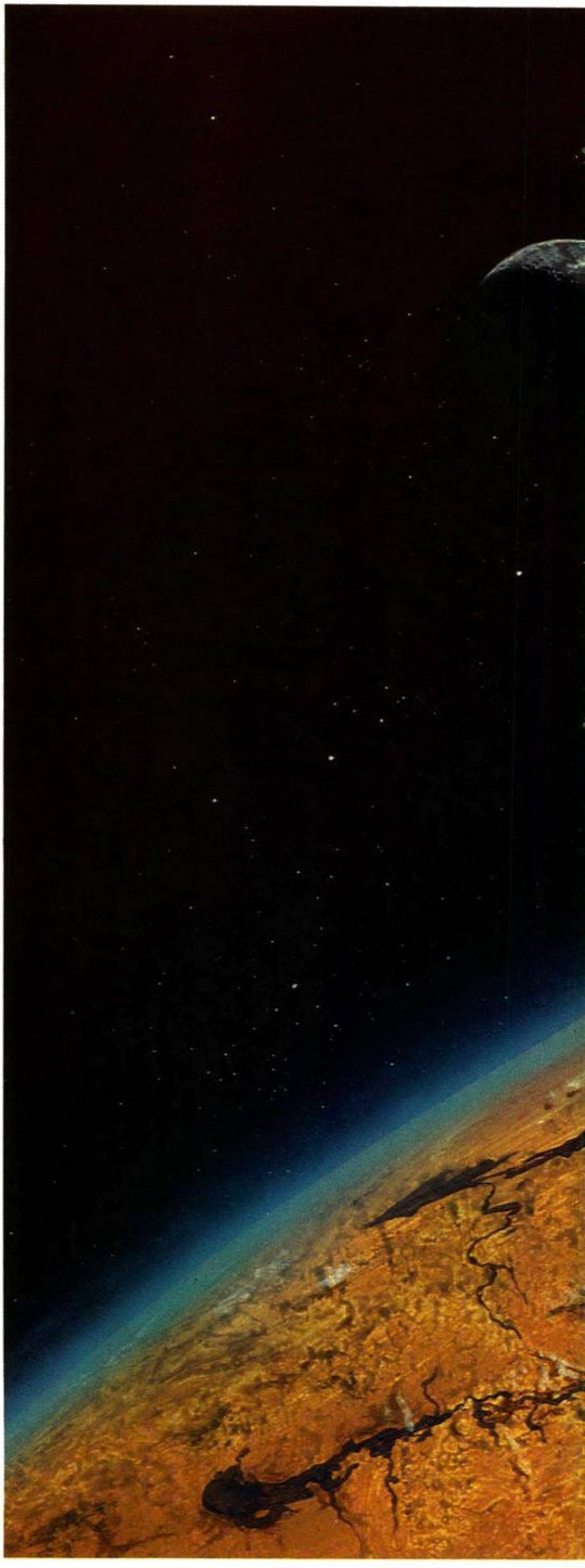
Today's Sun: The Main Sequence

The Sun is expected to spend 10 billion years on the main sequence, a period in which its luminosity will gradually increase. When it had just formed, the Sun shone a third less brightly than today, but by the end of the main-sequence phase 5 billion years hence, the Sun's luminosity will be three times what it is now. As the Sun's luminosity grows, dramatic changes will occur throughout the solar system.

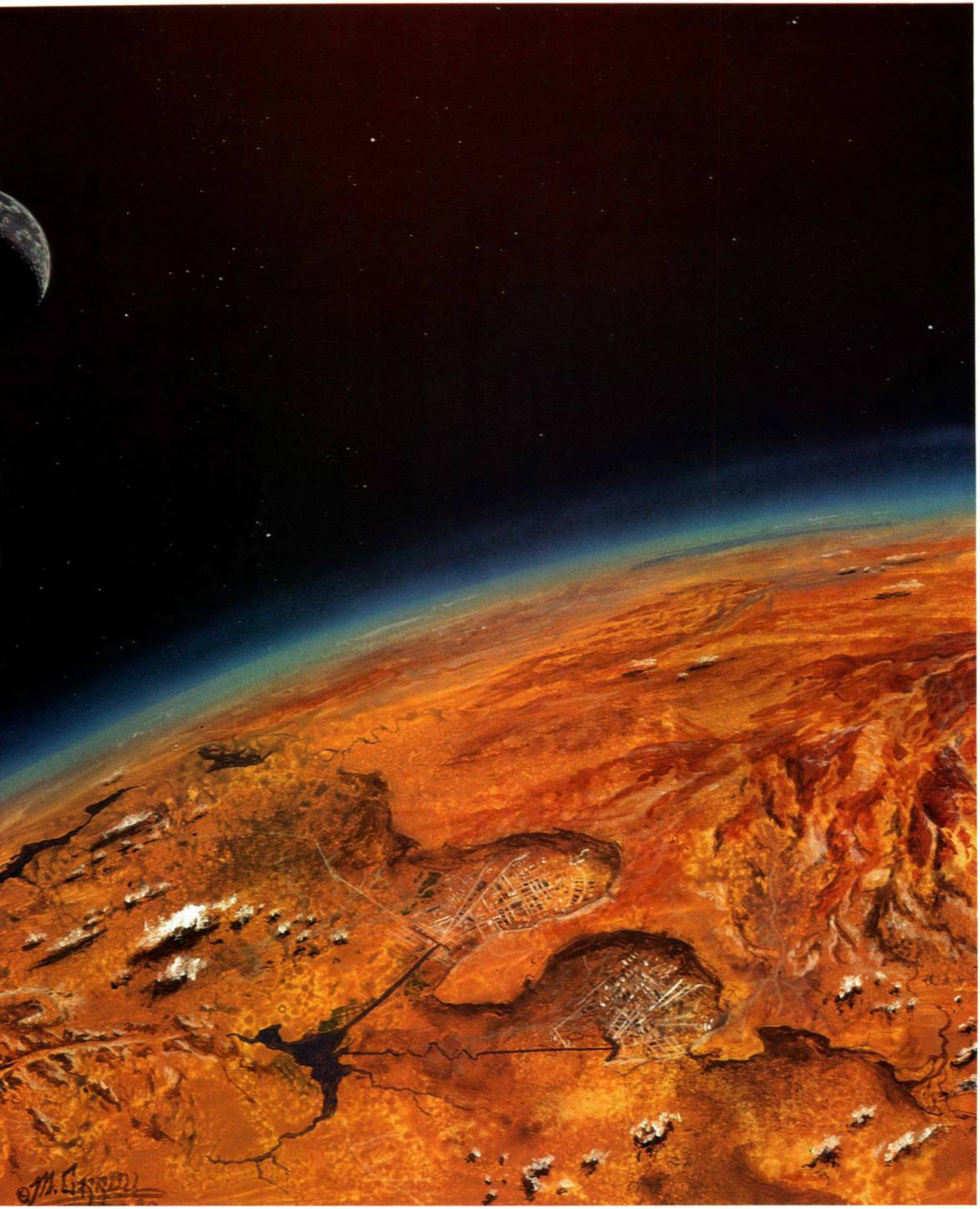
Soon after the planets formed conditions on Earth, Mars, and probably Venus permitted liquid water to exist, despite the Sun being 30 percent dimmer. The critical factors in having liquid water are a local temperature greater than 0° Celsius and an atmospheric pressure exceeding 6 millibars (1 millibar is 1/1000 of an Earth atmosphere).

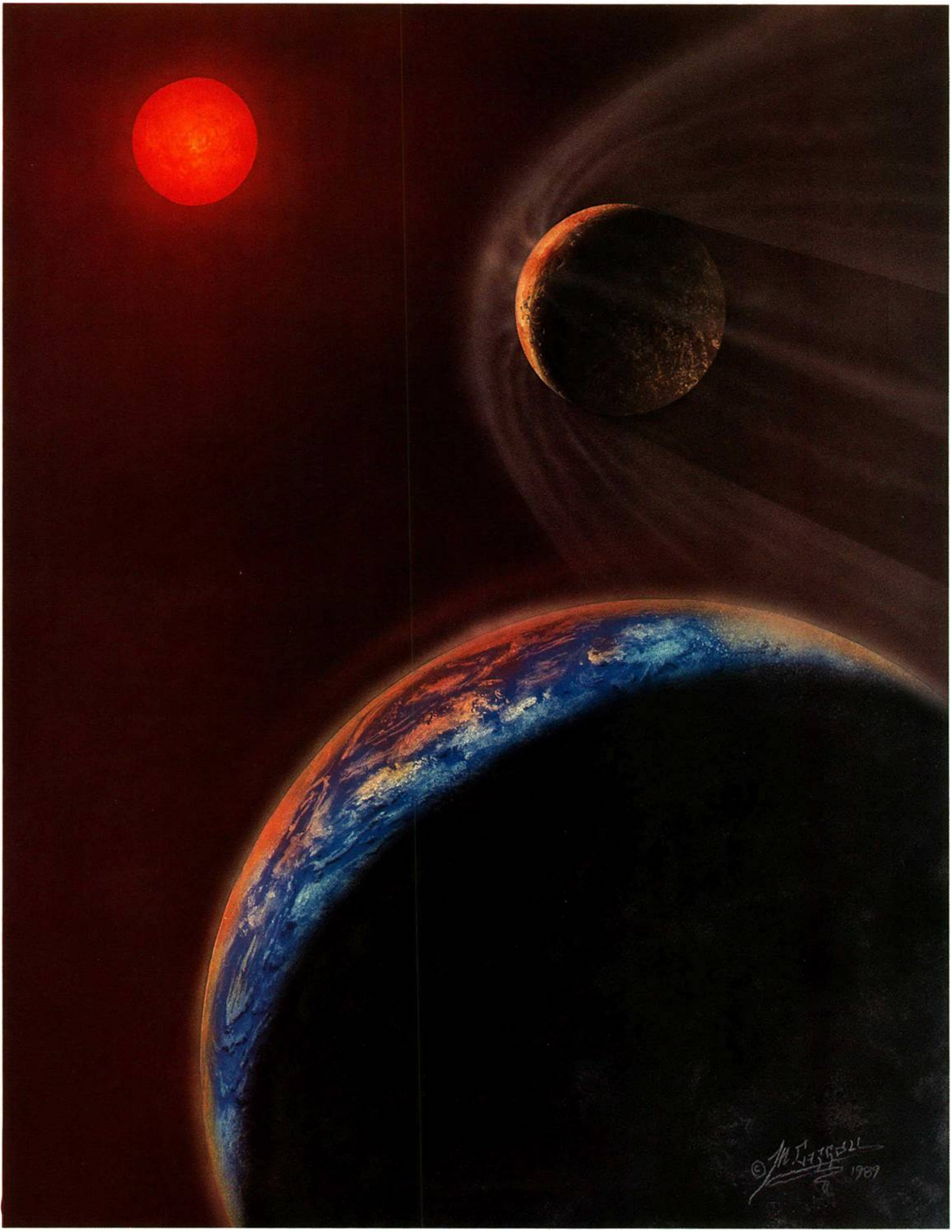
Venus probably had much the same amount of water as Earth when it formed. However, Venus receives twice as much sunlight as Earth, which produced a runaway greenhouse effect that would have destroyed any primordial ocean. Warmed by sunlight, water vapor rose high in the Venusian atmosphere where the Sun's ultraviolet radiation broke down the water into oxygen and hydrogen. The hydrogen escaped into space because of its small molecular weight and the oxygen eventually recirculated to combine chemically with the surface rocks.

Without liquid water, the carbon dioxide outgassed by Venus' volcanos would accumulate in the atmosphere, unchecked by weathering as on Earth. In terrestrial weathering, water, carbon dioxide, and silicate rocks chemically interact to produce carbonate rocks. Most of Earth's carbon dioxide now resides in its carbonate rocks, thanks to an abundant supply of liquid water and extensive weathering. However, Venus has never had enough water for much weathering and consequently retains to this day a thick carbon dioxide atmosphere. This crushing 93-bar atmosphere has produced a massive greenhouse effect that is responsible for raising the present surface temperature to 550°C, about twice what it would be without the



ALL TERRESTRIAL LIFE WILL DIE 500 million years from now when the Sun brightens by just 10 percent, a normal part of its main-sequence evolution.


©M. Carroll


© M. Carroll 1989

But if the Sun's luminosity was 30 percent less than today, how could the early Earth have had liquid water? Such a decrease now would freeze all water on the planet, yet there is no evidence that Earth's oceans ever froze. The key may lie in a natural regulation of temperature by the carbon dioxide greenhouse. Liquid water was stable on the early Earth because the atmosphere was richer in carbon dioxide and surface temperatures were warm. As the Sun gradually brightened, Earth's surface temperature initially increased. But this evaporated more water, causing rain and increased weathering, which thereby depleted the carbon dioxide. Removing the carbon dioxide reduced the natural greenhouse effect and kept the surface temperature from rising too much.

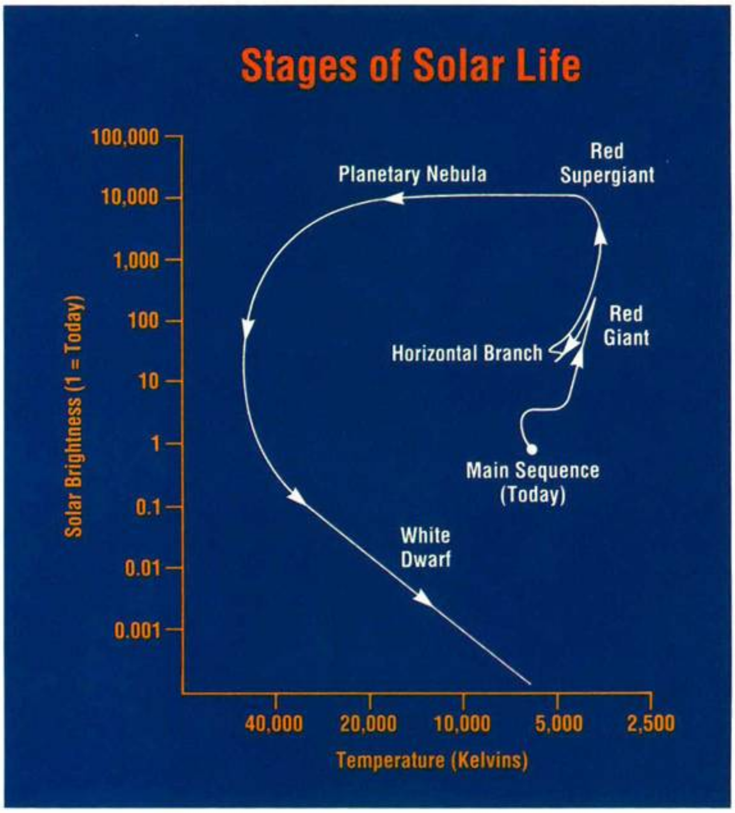
Mars, like Earth, had liquid water during an earlier epoch when the atmosphere was denser. (See "Searching for the Waters of Mars," August 1989.) The thinning of Mars' carbon dioxide atmosphere and the consequent loss of liquid water may have been caused by a breakdown of the carbonate rock cycle. On Earth the carbonate rocks created by weathering return their carbon dioxide to the atmosphere when the rocks are pulled down into the mantle by plate tectonics and melted. The gas is then released in volcanos.

On Mars geological activity appears to have slowed or stopped, perhaps because the planet cooled too much (a result of Mars' smaller size) and plate tectonics shut down. This implies that an Earth transported to Mars' distance would probably still have liquid water. Crater counts indicate, however, that the water-carved Martian channels (see "Surveying the Scars of Ancient Martian Floods," October 1989) are quite old and water has probably not flowed on Mars for billions of years. Martian summer temperatures today rise to the melting point of water in equatorial regions, but the average pressure of the planet's atmosphere falls slightly below the critical value of 6 millibars. Therefore, no significant amount of liquid water exists on the Martian surface now.

However, planetary scientists believe that a considerable reservoir of frozen water exists near the Martian surface. Estimates vary, but it is believed that Mars has enough water in the form of ice to completely cover the planet to a depth of at least 10 meters. Some lies in the polar caps but most ice is thought to be held as permafrost in the middle to high latitudes of the northern and southern hemispheres.

In a billion years the Sun's luminosity will increase by 20 percent. One of the first consequences of this may be the return of liquid water to Mars. The increase in heat will sublimate (vaporize directly from a solid state) the carbon dioxide frozen in the Martian polar caps. If enough carbon dioxide is released, the increased atmospheric pressure will allow liquid water wherever the temperature rises above 0°C. Furthermore, average surface temperatures will increase by at least 10°C, apart from any additional greenhouse heating caused by the increased carbon dioxide. This would likely allow surface water during Martian summers. Water exposed directly to the atmosphere, however, would still evaporate easily, so, as in the early liquid-water period, most permanent bodies of water will be iced-over lakes.

BASKING IN THE WARMTH of the red supergiant Sun 7 billion years hence, Pluto and Charon will briefly enjoy Earthlike temperatures.



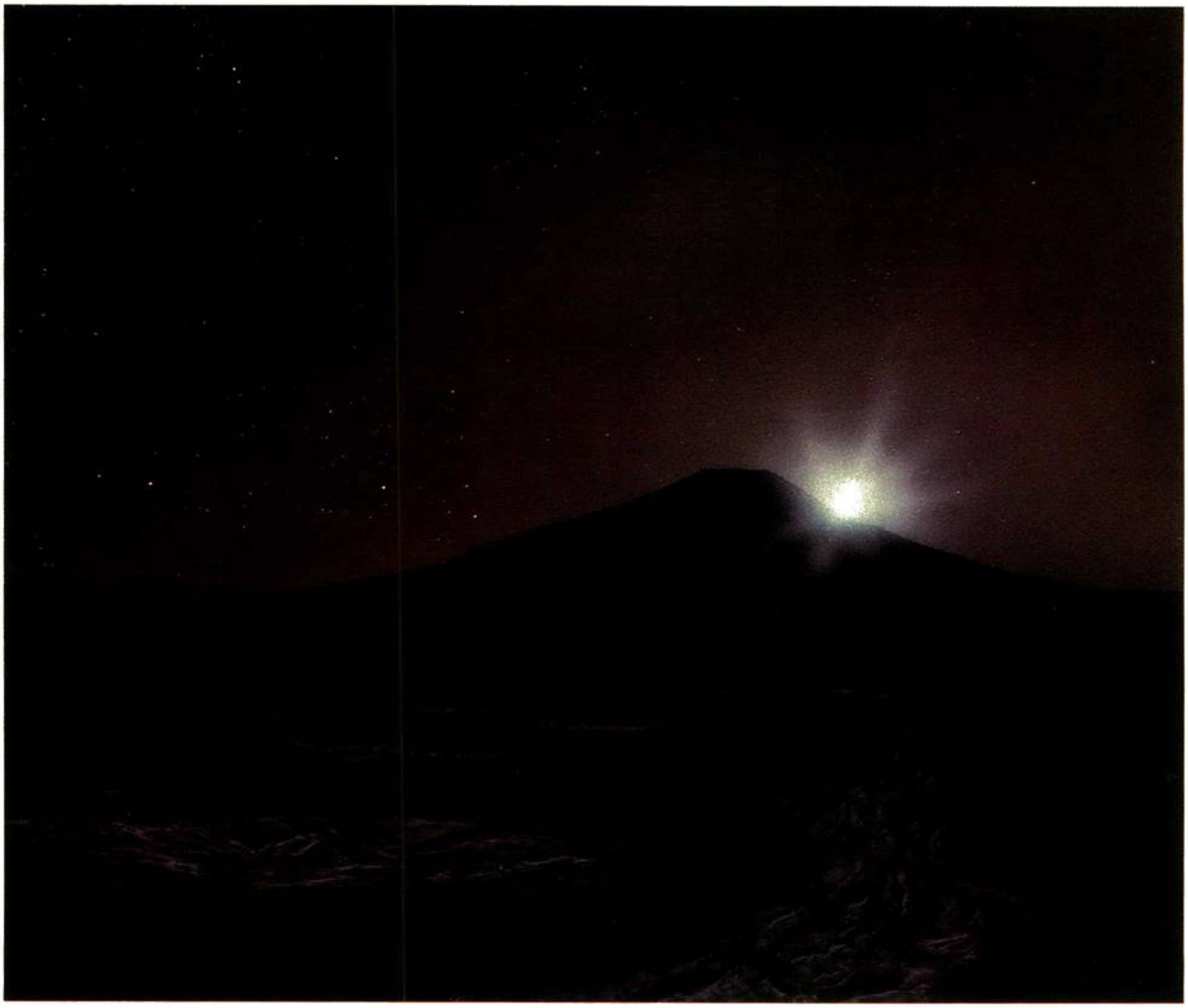
FROM MAIN-SEQUENCE STAR TO RED GIANT: The Sun will change greatly in temperature and luminosity as it ages.

But the new, denser Martian atmosphere will be absorbed in chemical reactions with the surface in about 10 million years because Mars lacks a continuing source of carbon dioxide such as volcanic outgassing. On Earth the geologic cycle pumps carbon dioxide back into the atmosphere, but Mars has no plate tectonics. Once its carbon dioxide is locked into rocks it is gone for good.

As the Sun's luminosity increases by 50 percent during the next 3 billion years, water vapor may increasingly come to dominate the Martian atmosphere. Rain and erosion could occur and the climate would generally be more Earthlike. Average temperatures would be about 25°C warmer than now, making it generally pleasant.

The long-term survival of a "wet" Martian atmosphere is threatened mainly by the Sun's ultraviolet light. Water molecules break up into hydrogen and oxygen when exposed to ultraviolet. When this occurs at the top of the atmosphere the hydrogen is quickly lost to space because of its small molecular weight. (This was the fate of early water on Venus.) On Earth, where nitrogen is the dominant atmospheric gas, water vapor condenses into low-lying clouds and is effectively imprisoned intact in the lower atmosphere.

On Mars water would initially be the prime atmospheric component but as ultraviolet light breaks it up, oxygen would accumulate. The Martian surface could then completely oxidize and the excess oxygen could become the major atmosphere constituent. This would confine water vapor to the lowest part of the at-



ONLY 1 PERCENT AS BRIGHT as today, the white-dwarf Sun sets behind a Martian volcano looming over a frozen landscape. This aged Sun will take billions of years to cool.

mosphere and its escape would slow or cease.

By the time Mars is becoming hospitable to liquid water (1 to 3 billion years from now), Earth will be losing its water through a runaway natural greenhouse. This will start to occur when the solar energy flux reaching the top of Earth's atmosphere increases by 10 percent 500 million years from now. Water vapor from the heated oceans will produce a steamy greenhouse effect. As terrestrial temperatures increase, more water will evaporate, leading to a further increase in temperature. Clouds may initially slow the greenhouse effect by increasing the reflectivity, but the greenhouse will ultimately win because solar heat will climb relentlessly. Barring any intervention by humans that might slightly hasten or delay the day, all life on Earth will become extinct in 500 million to 1.5 billion years.

Shining Big and Bright: Red Giant

During the Sun's main-sequence period, hydrogen "burns" into helium in the core. The central core eventually develops a mass of helium ash that contracts under gravity and heats up. This increases the temperature in the hydrogen-burning shell immediately above the core, which makes the shell brighter. In response to the growing radiation pressure from below, the layers above the shell expand and cool.

While the Sun is becoming cooler and redder, it also becomes much larger and more luminous. A billion years after the main-sequence phase ends (about 6 billion years from now), the Sun's radius will have increased to 0.2 AU, halfway to Mercury. If anyone is alive to see it, the Sun will loom fifty times larger in Earth's sky than it does now. The Sun's increased surface area gives it more luminosity, which will grow until the Sun shines with 300 times its present brightness. The surfaces of Mercury and Venus will melt and Earth's surface temperature will exceed 750°C.

As the swollen Sun sears the terrestrial planets the icy bodies in the outer solar system will thaw. Three of Jupiter's Galilean moons have vast amounts of water ice. Europa is covered with a crust of almost pure ice, and a 100-kilometer-deep ocean kept liquid by tidal friction may already exist below it. Ganymede and Callisto have ice and rock in roughly equal amounts, although their surfaces are predominantly ice. Precisely when the icy surfaces of these moons will melt depends mainly on how much ammonia is present.

A mixture of water and ammonia melts at –100°C, far below the melting point of pure water. Given a small amount of ammonia, melting would begin when the Sun is four times brighter than at present, soon after it leaves the main sequence. In this case liquid water could exist on Europa, Ganymede, and Callisto for most of the next billion years. With no ammonia, thawing would have to wait until the Sun brightened more, and water would remain liquid only a few hundred million years.

Huge amounts of water on these moons assure significant long-term atmospheres (despite their relatively low surface gravity) and associated greenhouses. But by the end of the red giant phase the temperatures of the Galilean moons will have soared to 250°C and water will be vaporizing and rapidly escaping. However, the high temperatures will probably not last long enough to completely "de-water" the moons.

Saturn's largest moon, Titan, already has a 1.5-bar atmosphere of nitrogen and methane. Unfortunately, little is known about Titan since a thick smoggy haze hides the surface from view. Some scientists have postulated lakes of ethane and methane on Titan's surface, but water ice is expected in any case. Since enough atmospheric pressure already exists, liquid water could form anyplace that reaches –100°C or 0°C, depending on whether ammonia is present. Allowing for some greenhouse heating these temperatures should occur during the Sun's red giant stage. Titan will probably have liquid water for 10 million to 100 million years.

The smaller moons and rings around Jupiter, Saturn, Uranus, and Neptune that contain water ice will sublimate their ices into gases which will escape into space in a relatively short time. No significant atmospheres will accumulate because these objects haven't enough gravity, and they will behave essentially like large comets.

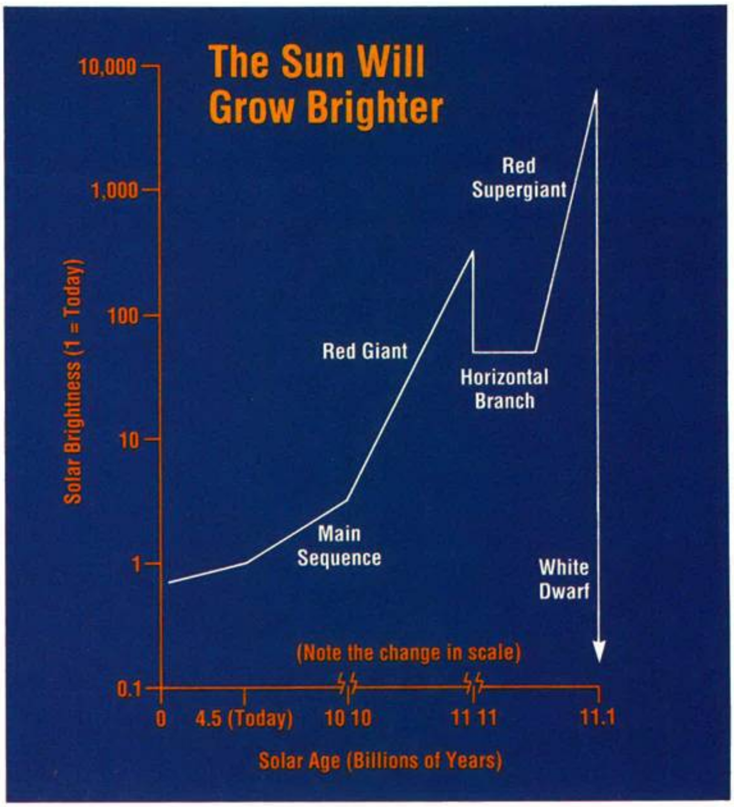
For low-mass stars like the Sun, the red giant phase ends abruptly in an event called the helium flash, the ignition of helium burning in the core. Its net result is a lowered solar luminosity. This stage lasts about 100 million years and is called the horizontal branch phase because of where such stars lie on the Hertzsprung-Russell diagrams of globular clusters. For a star like the Sun the luminosity will drop from 300 times the present value to "only" 50 times as its radius decreases and the surface becomes hotter and bluer.

During the horizontal branch phase temperatures in the solar system will drop to about 60 percent of the temperatures at the end of the red giant phase. The Galilean satellites will still be somewhat too hot for liquid water, but Titan should have some. The inner solar system would be much too hot for liquid water, even if any vapor had survived the red giant phase.

Devouring Its Children: Red Supergiant

The Sun's horizontal branch phase concludes with the build up of an inert carbon-oxygen core surrounded by a helium burning shell, which in turn is surrounded by a hydrogen burning shell. When this double shell develops, the luminosity again soars, ultimately making the Sun nearly 10,000 times brighter than now. Observationally, a star like this is a red supergiant and lies in the upper right hand corner of the Hertzsprung-Russell diagram (see page 25).

As a red supergiant, the Sun's radius will be 1 AU. At peak luminosity all temperatures in the solar system will increase ten times over their non-greenhouse values today. This is more than hot enough to melt the surfaces of each terrestrial planet. Even Pluto and Neptune's moon Triton, the coldest body in the planetary system yet measured, will have Sahara-like temperatures. The effect on the four giant planets, however, will be mainly cosmetic. In the most luminous supergiant stage their outer atmospheres will expand and be slightly stripped of gas. But because the planets are so large only a negligible amount will be lost and deep internal structures will be unaffected.

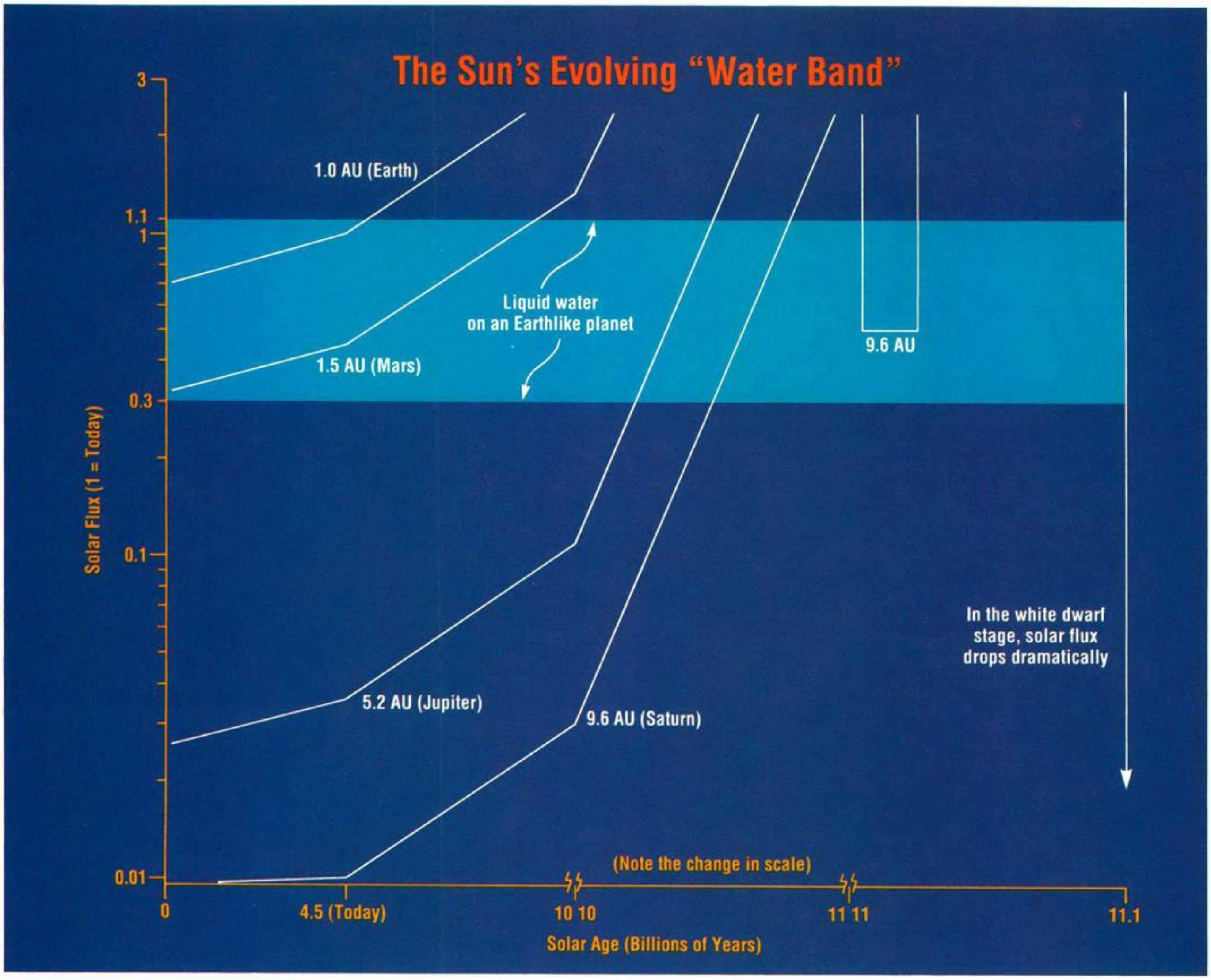


6.5 BILLION YEARS from now the Sun will blaze forth 6,000 times stronger than today.

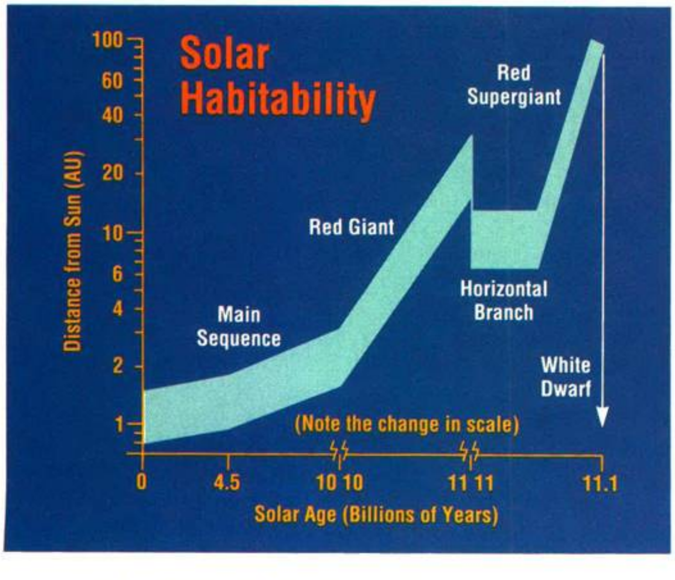
The surfaces of Mercury and Venus will melt to considerable depths and then the planets themselves will vanish, swallowed by the expanding Sun. Once the Sun's envelope engulfs them, gas drag will make both planets spiral inward and vaporize. The fate of Earth is not so certain, however. Astrophysicists think that the Sun's surface will ultimately extend to just beyond 1 AU. But the Earth, covered by an ocean of liquid rock, may nonetheless survive because it will no longer orbit where it is now.

As stars grow older they shed material in outflows of gas and dust. Ultimately as much as half the Sun's mass will be ejected into space, reducing its gravity. By the time the Sun's surface is approaching Earth's orbit, Earth will have retreated outward. (The retreat begins during the first red giant phase when perhaps 10 percent of the Sun is lost.) The ultimate fate of Earth is too close to call. The best bet is that the planet will survive the supergiant phase, albeit in a fused and glassy state. Mars and the rest of the solar system should also survive but in new and more distant orbits.

Toward the end of the supergiant phase the only place in the solar system where surface liquid water could exist will be Triton and possibly Pluto. As seen



AS THE SUN EVOLVES, solar intensity at different orbital distances will change. The light band shows the flux range that permits liquid water. At Earth (1 AU) the flux will soon become too high, while at Jupiter (5.2 AU) the liquid-water period begins in about 6 billion years.



AT A GIVEN SOLAR AGE the band's height shows where in solar distance liquid water will exist.

from Triton, the ruddy supergiant Sun will be nearly 4° across — eight times its apparent size now.

Skies throughout the solar system will be bright by day *and* by night as sunlight reflects from dust driven into space by the solar wind. If the Sun's dust shell resembles those observed around other red supergiants, the night sky could easily be as bright as Earth's present daytime sky. Its color may not match the red Sun because the small dust particles will scatter the bluer wavelengths more efficiently just like the gas molecules that give Earth a blue sky now. The night sky of those distant times will probably be a pinkish purple like what you see in the east on a clear evening just after sunset.

Contributing to the dust will be sublimating comets. Many planetary scientists believe that beyond Pluto a belt of comets exists beginning between 50 and 100 AU and extending outward for several hundred AU. This so-called Kuiper belt is probably the source for short period comets. (This is distinct from the better-known Oort cloud of comets which extends about one light-year and is the source of the more common long-period comets.) During the Sun's red

Water-Worlds Around Other Suns?

Some scientists have argued that life may be rare in the Galaxy because temperatures compatible with long-term liquid water occupy only a narrow range of distances from a given star. (For the Sun this "water band" lies between 0.95 AU and 1.5 AU.) The water band or life zone therefore has only a small probability of being occupied by a planet.

Water bands are more narrow for other stars because most are less luminous than the Sun. However, as any star evolves, its water band moves outward, even during the long-lived main sequence phase. The band also becomes wider in an absolute sense. The inner and outer boundaries typically double during the star's main sequence phase.

Theoretical models and knowledge of early water on Mars indicate that long-term liquid water can exist on terrestrial planets when stellar energy fluxes at the top of cloudless atmospheres lie between 0.3 and 1.1 times the solar flux at Earth today.

If we factor in an evolving water band, we can ask how our own system of planets would fare had it formed around a typical solar-type star that started with about 35 percent the present Sun's luminosity. (The real Sun began with 70 percent its current brightness.) Such a luminosity fits several nearby stars: Alpha Centauri B, Epsilon Eridani, and 40 Eridani A.

In this scenario, Mercury would be too hot and Mars and the bodies beyond too cold for stable water. Venus and Earth would initially have stellar energy fluxes of, respectively, 0.7 and 0.35 times Earth's present flux. Thus, neglecting clouds, both planets would have liquid water. Clouds would permit water on Venus initially, but not on Earth.

Within 7 billion years the star's energy flux at Earth would increase from 0.35 to 0.5 and surface water would be abundant, with or without clouds. At around this time a cloudless Venus would begin to lose its water in a runaway greenhouse; Earth would keep its water until the end of the main sequence phase in about 8 billion years. Mars could have water toward the end of the main sequence stage for several billion years.

In this hypothetical example two Earth-mass planets would have large quantities of liquid water for more than 7 billion years. However, stars with initial luminosities below about 30 percent of the present Sun will spend so long on the main sequence that their water bands will not widen significantly in the lifetime of the Galaxy.

At the upper end of the scale, in stars that begin their lives with somewhat more than the Sun's luminosity, both Earth and Mars could have water for much of the main sequence period. But stars can get too big: Those that form bright enough to permit liquid water at the distance of the Galilean satellites spend less than 100 million years on the main sequence. It seems unlikely that life could evolve significantly in such a short time, even though the water bands around these stars are very broad.

Thus we come to an interesting conclusion: Taking into account the expanding water band, our own planetary system would actually have had a better *a priori* probability of evolving life if it had formed around a more typical G and K type star than around the Sun! Of course, we really don't know how common planetary systems are. But if our system is typical, the Galaxy may well have a significant number of potentially habitable planets.

giant and especially the supergiant phase, the comets of the Kuiper belt will begin to sublimate their ices and release large amounts of dust.

End of the Road: White Dwarf

At the end of its red supergiant phase, about 7 billion years from now, the Sun will blow off its extended envelope in a powerful solar wind, thus creating a planetary nebula (see "The Hottest Stars," February 1990). After the planetary nebula stage the remaining stellar core will be a compact, very hot, inert ball of carbon and oxygen. The core will halt its contraction and stop generating new heat as the force of gravity meets its match in the outward pressure of electrons crammed together in a state physicists call degeneracy. Although this white dwarf Sun will have only half its present mass, it will be packed into a volume the size of Earth with a density of a ton per cubic centimeter.

Losing half of the Sun's mass will double the orbital distance of Earth and all surviving planets. Of course, the orbits of comets in the Kuiper belt and the far-flung Oort cloud will also double. In the case of the Oort cloud perhaps half of its comets will be lost to interstellar space through the gravity of passing stars and the tidal force of the Galaxy itself.

Between the supergiant phase and the white dwarf stage the Sun's luminosity drops a million-fold. As solar luminosity falls the chill of interstellar space will follow the retreating warmth sunward. Each surviving body will again have surface temperatures compatible with liquid water for a few hundred thousand years.

As seen from Earth, now orbiting at 2 AU, the white dwarf Sun will have an apparent size of 9 arcseconds, smaller than Venus or Jupiter today. As a new white dwarf the Sun's luminosity will be barely a hundredth of what it is today. Solar system temperatures will drop by a factor of a third due to the luminosity decrease and another two-thirds because of the increased orbital distances. On the resolidified Earth temperatures will be a chilling –200°C, about that of Pluto today.

The shrunken Sun will shine white-hot at first. Then as it radiates ceaselessly for billions of years, its color will shift down through the spectrum toward yellow, orange, and red. Eventually the Sun will be a cold, black dwarf governing a retinue of fused and hard-frozen worlds orbiting in a darkness lit only by the light of the distant stars. ☐

Daniel Whitmire is an astrophysicist at the University of Southwestern Louisiana specializing in the origin and evolution of planetesimal disks. Ray Reynolds is a scientist at NASA's Ames Research Center where his research focuses on planetary structure and evolution.

Return to a New World

When the *Galileo* spacecraft arrives at Jupiter in 1995, it will answer lingering questions about the planet's extraordinary satellites.

by Joel K. Harris

Anxiety is the key word in Pasadena these days. Members of the *Galileo* spacecraft science team at the Jet Propulsion Laboratory have a five-year wait before their long-delayed voyager reaches Jupiter. Provided all goes well and the spacecraft does reach Jupiter, it will deploy a robot probe and perform numerous scientific experiments at the planet.

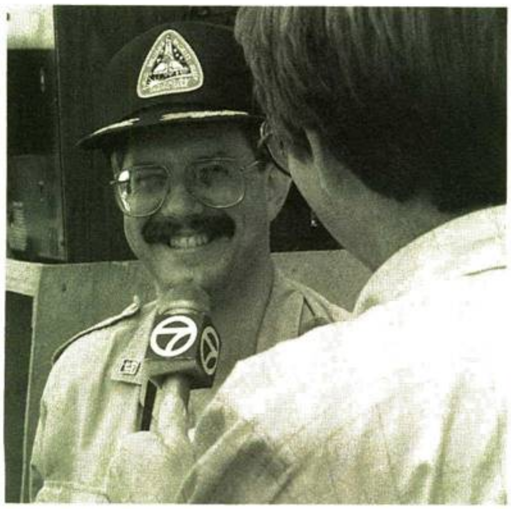
Galileo's trajectory is so complicated, however, that it has the scientists decidedly uneasy. Before *Galileo* leaves the inner solar system, it will get a gravity assist from passing near Venus and Earth. "The trickiest part of *Galileo's* mission comes when it is less than one astronomical unit from the Sun," said interdisciplinary scientist James Pollack. "Many people will breathe a sigh of relief when that part of the flight is over."

The three-ton robot spacecraft began its roundabout voyage to Jupiter on October 18, 1989, after a series of frustrating delays. Scientists are monitoring the spacecraft's progress carefully because of the complicated trajectory required to reach Jupiter. "One could lose a great deal of sleep over what might happen to the spacecraft on the way to Jupiter," said Pollack. *Galileo's* long Venus-Earth-Earth gravity assist trajectory will carry it to Jupiter in seventy-two months after first flying by Venus and twice by Earth for gravity assists that will help propel the spacecraft toward its destination. The trajectory is a bit like running through a cluttered rumpus room filled with children's toys without stubbing your toe — and at 40,000 miles per hour.

Despite the spacecraft's convoluted journey, *Galileo* scientists are optimistic. "The harsh environment of space is where spacecraft like to be," said project scientist Torrence Johnson. His colleague, science manager Clayne Yeates agrees. "The safest place for *Galileo* is in space and not on the ground."

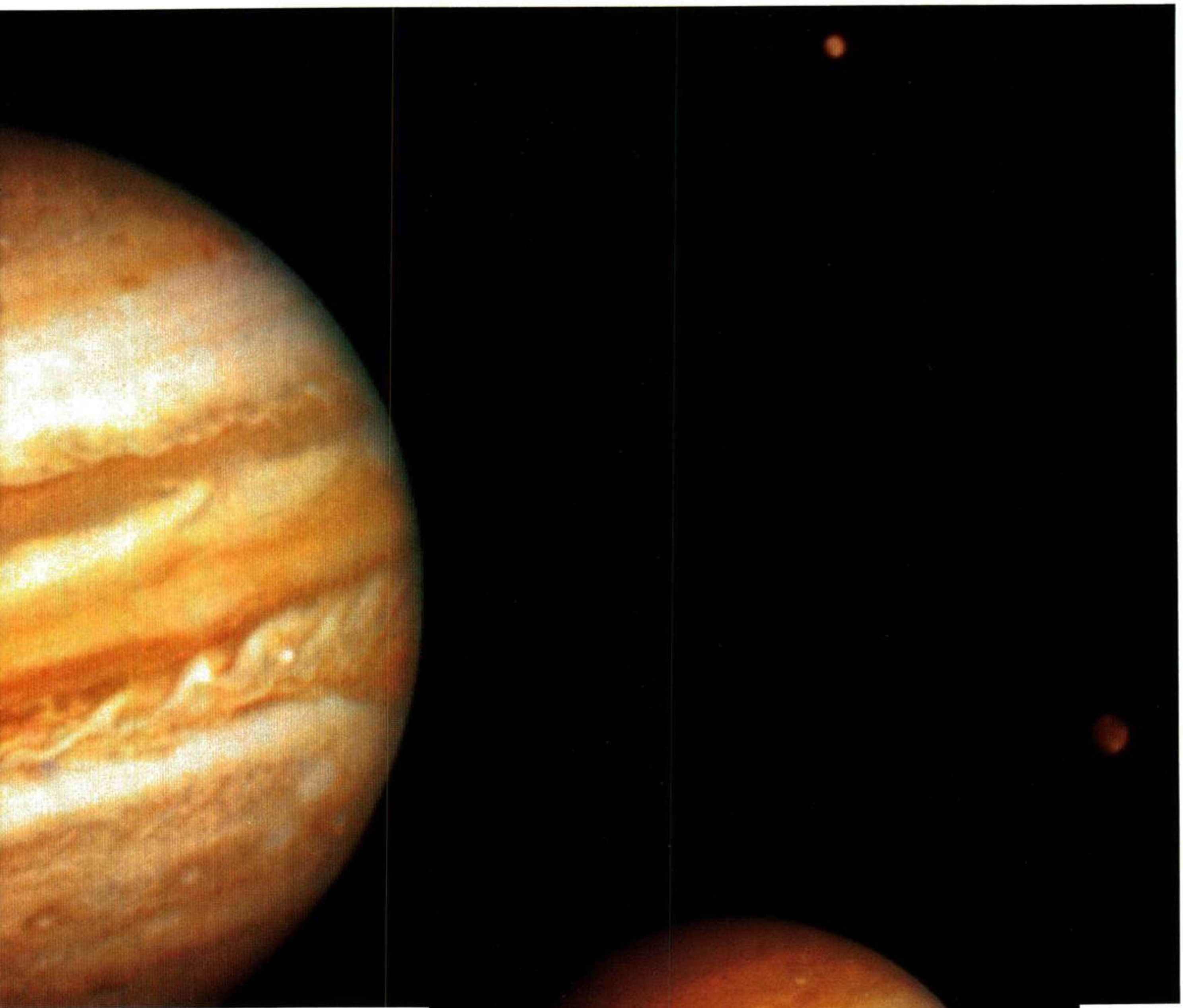
The early life of the *Galileo* mission is a tense, stop-and-go story. The mission's character changed several times due to fiscal and hardware constraints, the *Challenger* accident in 1986, and the heightened safety concerns for astronaut crews following the *Challenger* investigation. These factors slowed the *Galileo* project to a near standstill. But after a long, arduous journey to see *Galileo* launched, scientists are finally looking ahead. "The science opportunities are the silver lining in the dark cloud," said probe project scientist Richard Young of NASA's Ames Research Center.

"If the spacecraft's high-gain antenna fails to deploy, we're dead in the water." —Torrence Johnson, project scientist



Plenty of Fears and Hopes

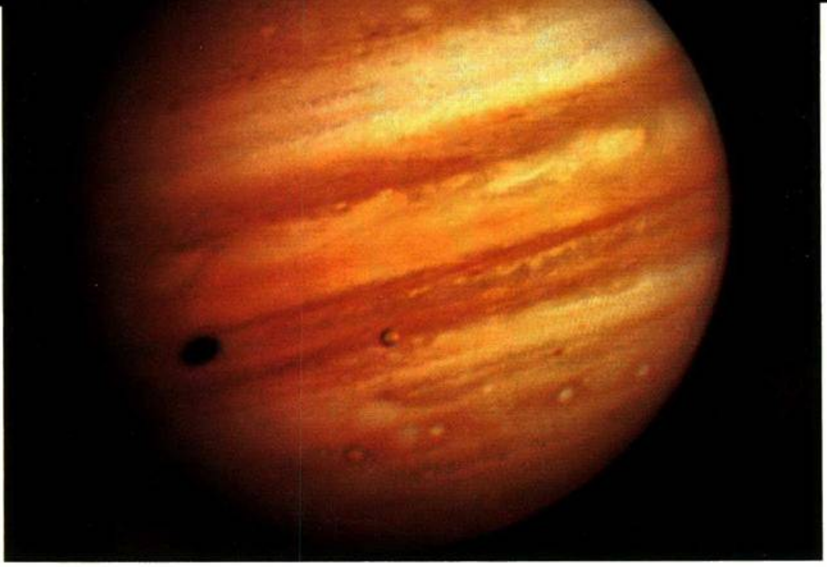
The real complexities of what lies ahead for *Galileo* become apparent when project scientists talk about the key spacecraft events. Project scientist Johnson is concerned about slow data rates prior to the deployment of the spacecraft's high-gain antenna, which won't occur until after the first Earth encounter in December 1990. (This is to protect the antenna from high temperatures when the craft is relatively close to the Sun.) Without



JUPITER AND ITS MOONS will be the focus for *Galileo* when it arrives in December 1995 to take a detailed look at the King of Planets.

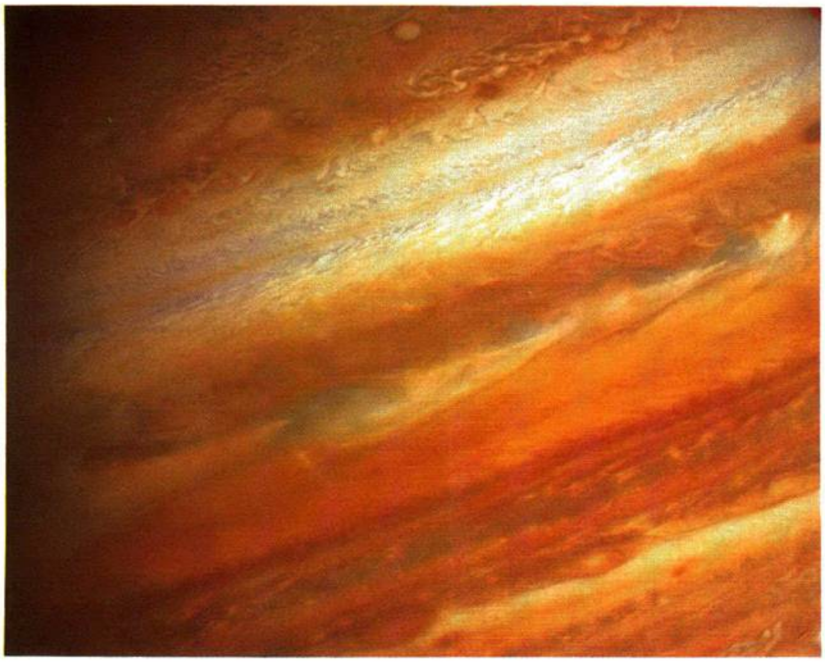
the high-gain antenna, the transmission rate with the low-gain antenna is either 7,000 bits per second or 40 bits per second. The data transmission rate with the high-gain antenna is 134,000 bits per second.

"The low-gain rates just don't give us very good technical information," said Johnson. "Consequently, we don't know exactly how the spacecraft is doing. The craft is simply a better vehicle when it is in Jovian flight configuration." Johnson stated that a failure to deploy the high-gain antenna would jeopardize the mission. "If it fails to deploy properly,



TANGLED CLOUD BELTS AND BANDS will be explored by a probe dropped into the Jovian atmosphere by *Galileo*.

THE GREAT RED SPOT, a giant cyclonic storm, will show new details never before seen when *Galileo* examines it with an array of instruments.

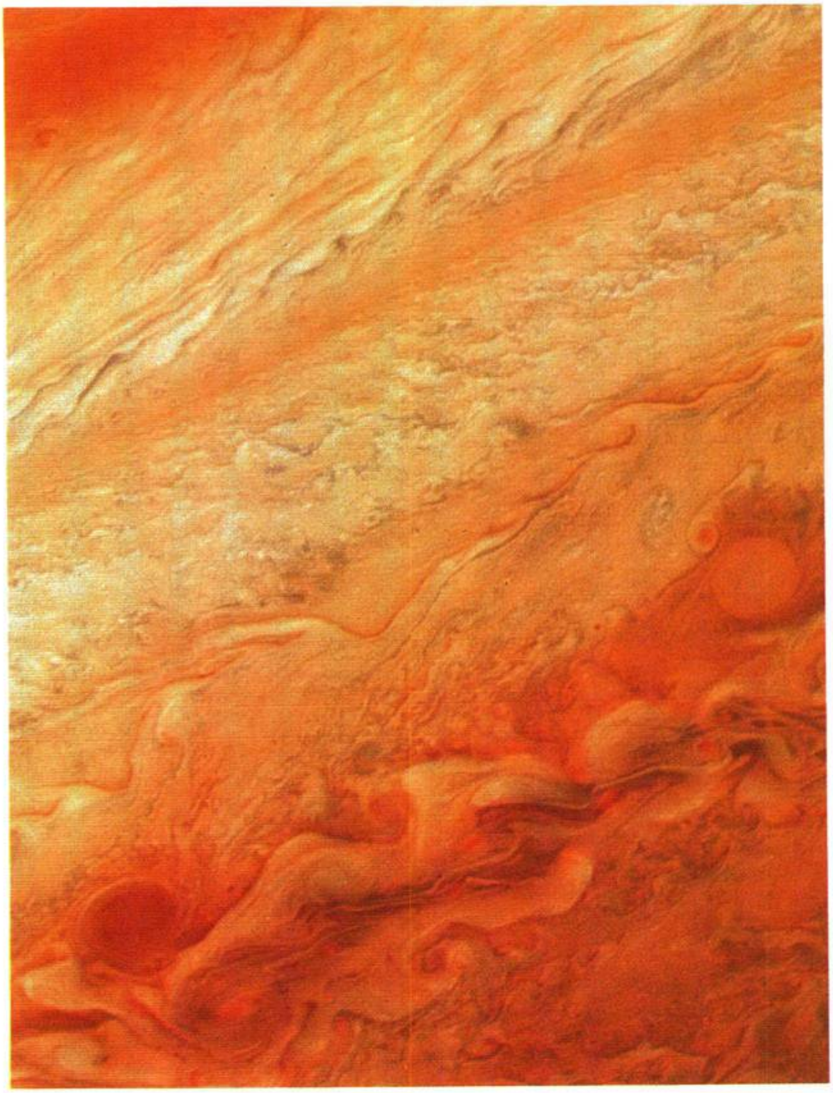


WINDOWS INTO THE DEEP, blue-gray regions on Jupiter let scientists peer into the planet's lower cloud decks.

we're dead in the water as far as science at Jupiter is concerned," said Johnson.

The critical event that Johnson is concerned about is the sequence of operations that will happen forty-eight hours before the spacecraft flies over Jupiter's moon Io. At that time the spacecraft will drop its atmospheric probe, ignite its main engine, and enter into orbit around Jupiter. "Should any of these events not happen on time or at all, there won't be any ensuing orbits to effect any fixes," said Johnson.

But for Clayne Yeates the worst is now over. "My biggest concerns centered on the mission before and during launch," said Yeates. "The whole episode was a nail-biting experience." Once free of Earth's gravity, *Galileo* underwent a four-day



HIGH WINDS KINK CLOUDS in Jupiter's equatorial regions. *Galileo* will explore these winds and their effect on the planet's global circulation patterns.

test during which scientists activated all but two science instruments, made calibrations, performed a complete systems inspection, and corrected the spacecraft's trajectory using a small thrusting engine on the craft. They also gathered data on a large solar flare after *Galileo* left the Earth-Moon system.

One of the concerns about the early part of the flight is the spacecraft's temperature as it approaches Venus and draws near the Sun. "*Galileo* must maintain a precise solar point within less than 15° or solar heating will become a problem," said Yeates. "But the spacecraft's sunshields and onboard fault protection software are designed to prevent any thermal damage." Yeates reports that so far the spacecraft's temperature closely matches predictions by JPL scientists.

The twin Earth encounters in 1990 and 1992 represent another risky time for *Galileo*. The ever-increasing field of space debris encircling Earth is a potential danger for many space users. But Yeates says the threat from Earth's orbiting junkyard is slight. "The debris is located in a narrow band and is not widely scattered. The orbits of the large pieces are known, and the whereabouts of the smaller bits, say, a millimeter in diameter, are well estimated. Precise navigation should enable us to avoid any potential areas of danger."

Strikes from interplanetary micrometeorites are also a possible threat. Avoiding micrometeorites is less certain than satellite debris. "We don't know the location and velocity of every one of these things in interplanetary space," said Yeates. "There have been suspected micrometeorite collisions with spacecraft in the past, but none seem to have destroyed any vehicles." A system of multilayered metal blankets protects *Galileo* from these solar system buckshot.

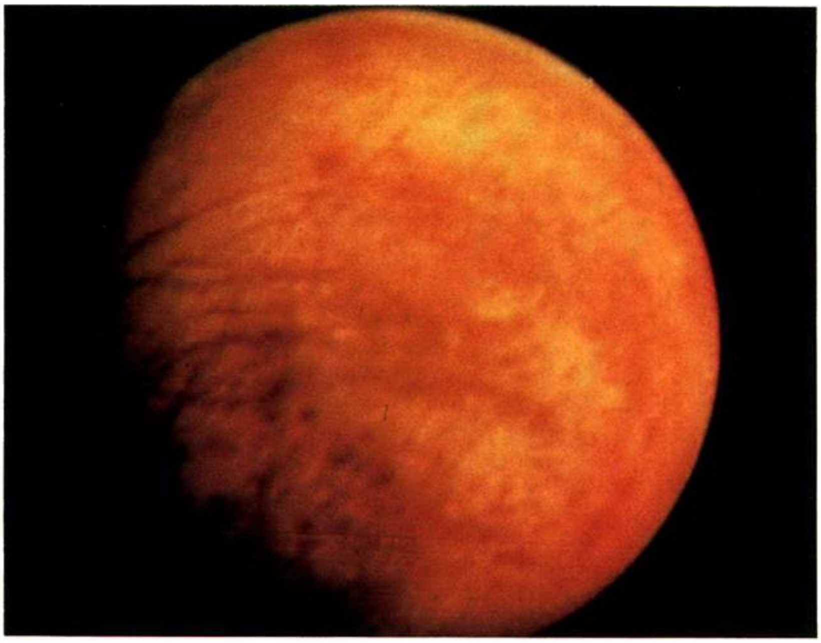
Richard Young's *Galileo* gremlins take a different form. "The final 150 days before planetfall will be white-knuckle time for the probe team," Young admits. It would be disastrous if the probe explores a "less interesting" area instead of a representative portion of the planet's atmosphere. The greatest danger during this period — a Jovian lightning strike on the probe — is pretty unlikely, according to Young. "Most Jovian lightning has been seen at –49° latitude. The probe is targeted for +6.5° latitude to avoid any plume regions," said Young.

James Pollack is looking forward to *Galileo's* long cruise to Jupiter. He views the additional time as an excellent chance to watch for temporal changes in the Jovian atmosphere as the spacecraft approaches the planet. Pollack is especially buoyant whenever spacecraft reliability issues are raised because of his experience as a science team member on the *Pioneer* and *Voyager* missions.

"If one looks at *Voyager 2,* you have to remember the problems the vehicle had a few months after launch in 1977. We all said it would be great if the spacecraft worked at Jupiter, let alone Saturn. And despite the scan platform trouble at Saturn, the engineering team understood the trouble well enough to get the hardware to perform perfectly at both Uranus and Neptune.

"One particularly fortunate outcome of the *Galileo* launch delay was a discovery concerning the maneuvering thrusters. Had we not learned of the problems with them, it would have been most unfortunate for the mission." During the delay engineers discovered a design flaw that might have resulted in the explosion of *Galileo's* retropropulsion module if the thrusters were used for a sustained period.

The two probe investigators, Pollack and Young, will not be sitting idle until *Galileo* arrives at Jupiter. They are looking forward to the spacecraft's flyby of Venus. "Observing the night side of Venus presents us with some fascinating data on thermal emissions from the clouds around the planet," said Pollack. "This is interesting for two reasons. First, we will learn about deeper winds in Venus' atmosphere. Second, the water vapor ratio is not constant from cloud bases to the surface. The crucial question is: What is happening to water vapor on Venus?



THE JOVIAN MOONS will be scanned much more closely by *Galileo* than by the two *Voyagers*. The largest of Jupiter's moons, Ganymede, is mysteriously cratered and grooved.

Perhaps it is the mechanism for driving the fierce winds in the atmosphere."

Galileo's Near Infrared Mapping Spectrometer (NIMS) is an ideal remote-sensing instrument for determining the distribution of various gases in the Venusian atmosphere. NIMS will record six hours of data during the Venus flyby on February 9. During the encounter NIMS' 9-inch f/3.5 Ritchey-Chretien telescope will look for variations in heat energy and water vapor in the Venusian clouds. "We really hope to get a better idea of what has happened to the water on Venus," said Young. "Was there ever water in liquid form? If there was, where did it go and why is the planet so dry today?"

What to Expect at Jupiter

Should all go according to plan, *Galileo* will reach Jupiter in December 1995. Torrence Johnson knows exactly what will happen if the mission goes without a hitch. Johnson says the basic *Galileo* orbital flight strategy is similar to that of *Voyager* in that there is a limited amount of flexibility during each satellite flyby and there are some flight characteristics that can be adjusted days or even hours before *Galileo* passes a particular moon. However, this "refinement process" concerns mainly the remote-sensing instruments, as the fundamental orbital tour must be arranged many months before the spacecraft reaches Jupiter. *Galileo* will make eleven orbits around Jupiter — like a 10-cushion billiard shot — the objective being to miss, not hit, each of the four moons lying on the pool table.

The *Galileo* scientists confidently expect the photos of Jupiter and its major moons to be much more detailed than those produced by *Voyager*. *Galileo* carries a solid-state imaging system that is more sophisticated than those carried by earlier spacecraft. With an 800 by 800 picture element CCD, the 1500mm f/8.5 Cassegrain optical system is expected to yield average satellite surface resolutions of 20 to 50 meters. By contrast, the *Voyager* cameras averaged 1 kilometer resolution on most of their satellite photos.

The smallest clearly discernible object the *Voyager* cameras saw was the width of the Grand Canyon. *Galileo* will see objects as small as a semi-trailer truck. "Frankly, Europa was not seen well or understood," said Johnson. "Io is also going to be interesting. I think that getting *Landsat*-scale photos of Io is likely to be very exciting. I suspect we will have to revise our thinking about Io's volcanism, atmosphere, and how the volcanos relate to those on Earth."

Yeates is excited because the average flyby altitude of the four Galilean moons is 50 to 100 times closer than with *Voyager*. "With this mission we actually get closer looks at the four moons than *Voyager* did. As you move outward from Io, the innermost satellite, the composition, density, and character of each moon varies. The innermost moons are denser than the outer worlds, which are less evolved and primitive with lots of ices and ancient impact cratering. Just by studying the actual trajectory at each satellite encounter, we can create more accurate models of the internal structure and the gravimetric nature of the moons."

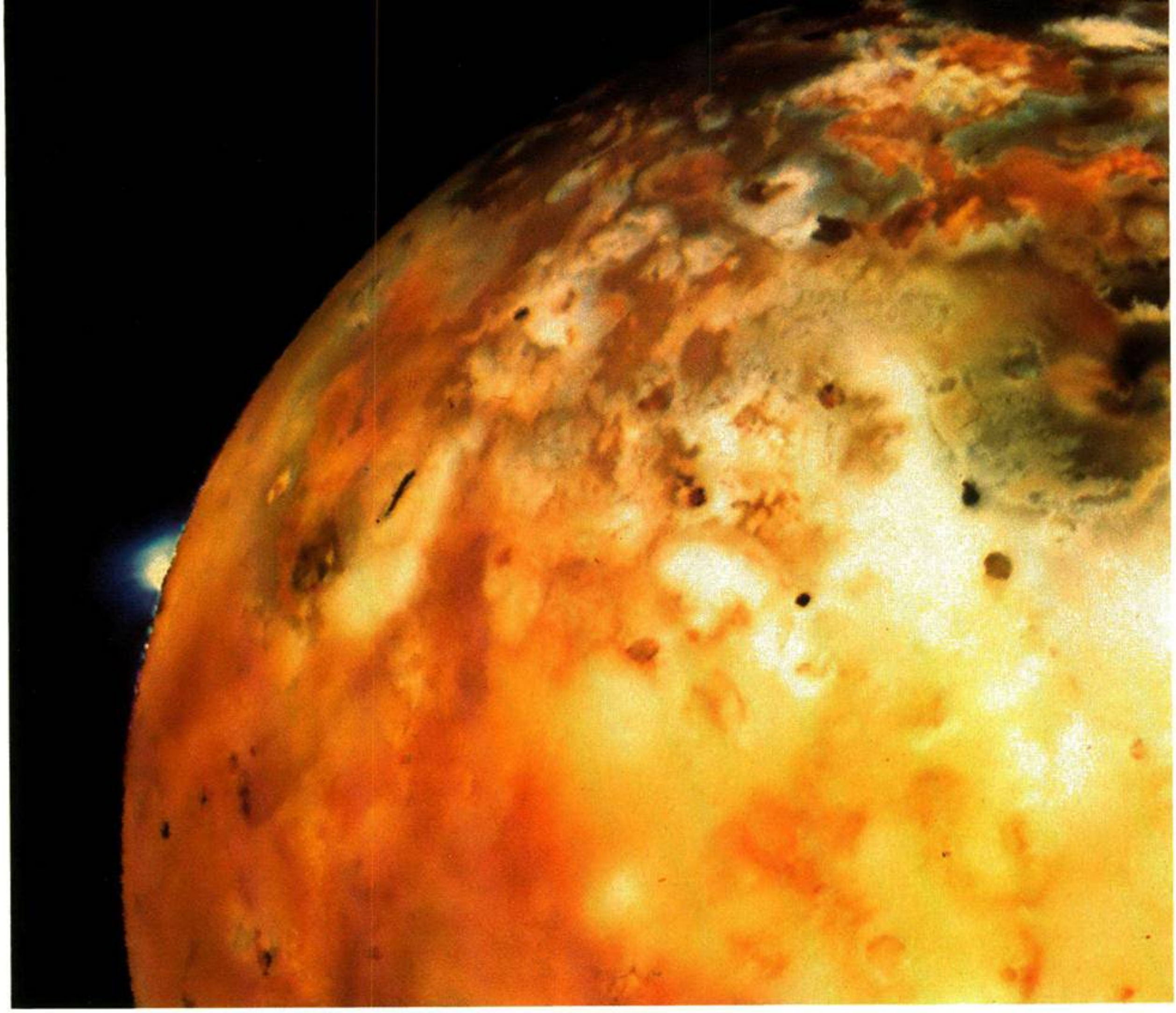
The probe's atmospheric sampling is the key to *Galileo's* enormous promise. This direct sampling is a foremost concern of probe team members Young and Pollack. "You can only go so far with remote-sensing science," Pollack says. "The next step in studying a planet is direct sampling that leads to what we call 'ground truthing' of remote data. As the orbiter measures only to a certain depth in the atmosphere, the probe can augment such information. Similarly, remote sensing can help globalize data collected at the one probe entry site. The two sets of measurements complement one another."

One set of measurements Pollack will be studying very closely is the depth and abundance of Jovian water clouds. What Pollack terms "cosmogonic reasoning" leads him to believe water clouds may exist at some depth in the planet's atmosphere. The sheer volume of solar nebula material Jupiter inherited ought to yield a significant degree of water vapor, he feels.

Jovian winds and their origins will be high on Rich Young's list of crucial topics for the probe. How deep do Jovian winds go and at what speeds do they blow? Is it the internal heat of Jupiter that drives the dynamics of the atmosphere or does heat transfer from water vapor play a major role? What will it mean if the probe finds winds that change direction through various depths?

Two major interests for the science team are the Jovian ring and the magnetosphere. *"Voyager 1's* images of the Jovian ring are smudgy. And even *Voyager 2's* better images were mediocre. At Uranus and Neptune we were better prepared to look for any suspected rings."

Yeates believes that some of the riddles of the Jovian magnetosphere will be solved when *Galileo* arrives. The Jovian magnetosphere is a big deal, literally: It is the largest structure in the solar system. If our eyes could see it, it would stretch over five times the angular size of the Full Moon (2.5° in diameter). The magnetosphere rotates and wobbles like a warped long-playing record disk seen edge-on.

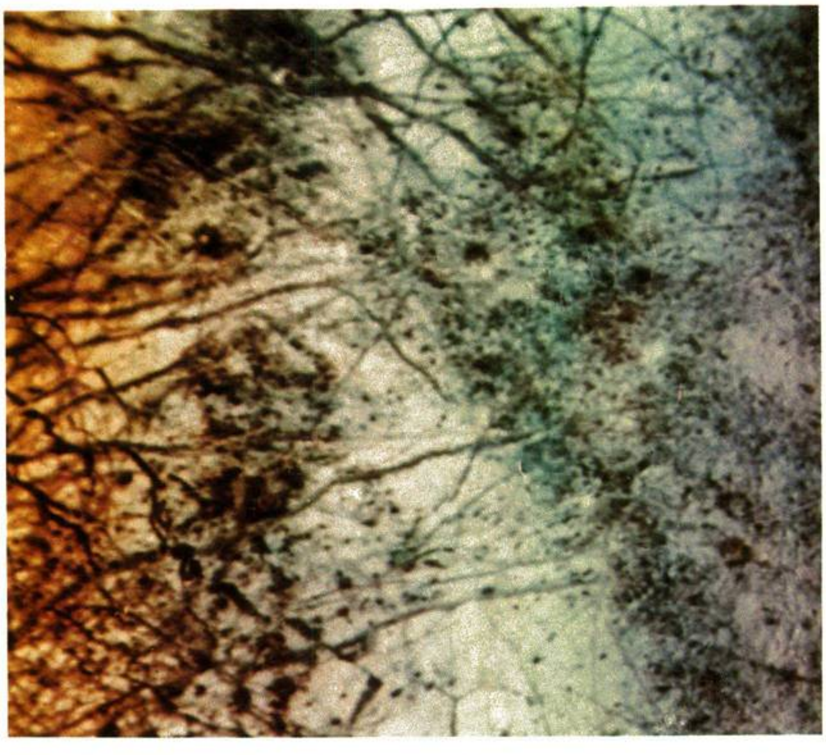


A VOLCANO ERUPTS ON IO, the innermost of Jupiter's major moons. Io's surface is continuously being altered by heavy volcanic activity.

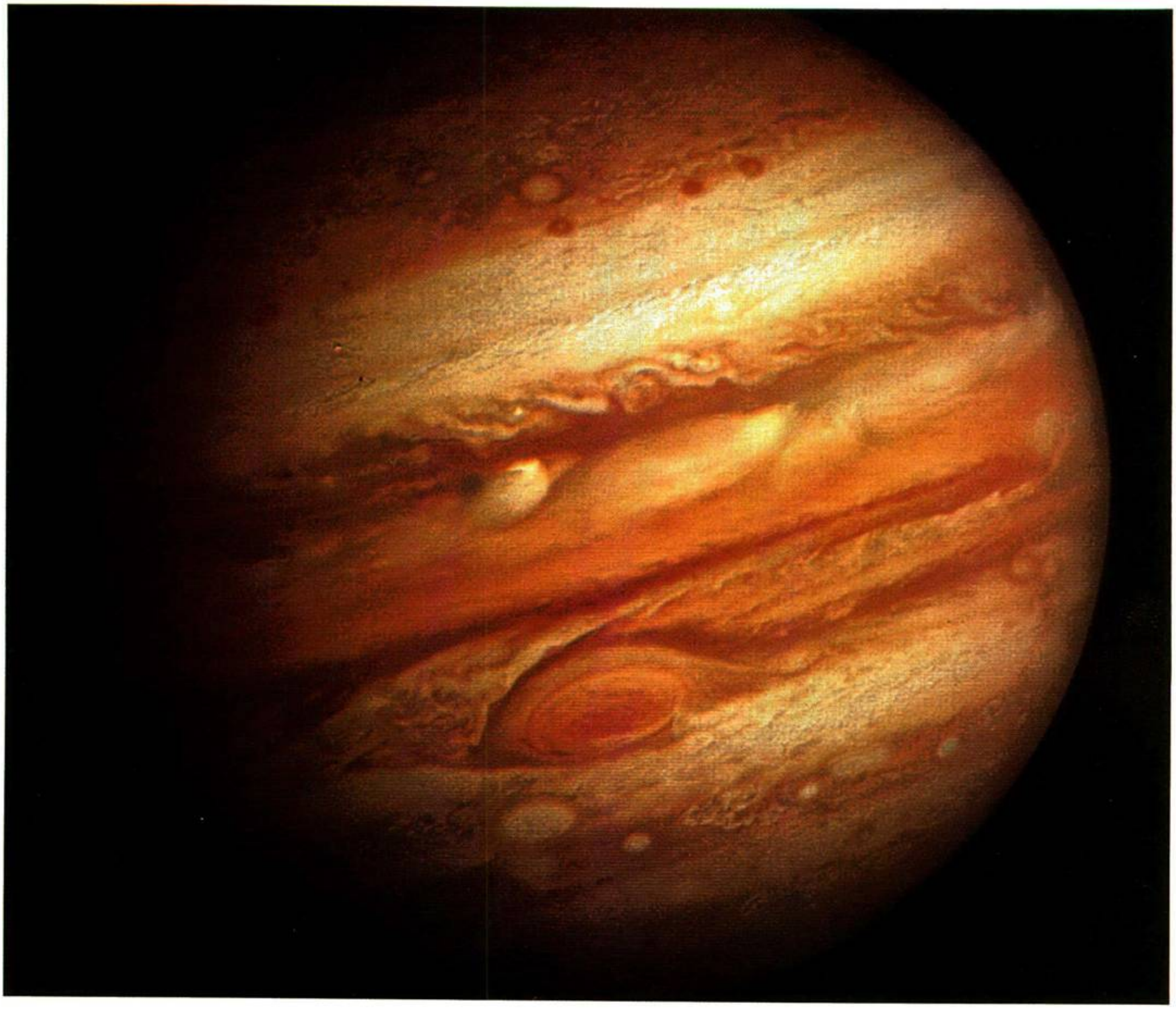
"The Jovian system is very dynamic, and the *in situ* measurements over time are most helpful to us," said Yeates. "Jupiter's aurorae, magnetosphere, and the Io torus interact with one another. There is a big energy balance problem here and the orbiter should help us to untangle the situation."

The Heart Stoppers

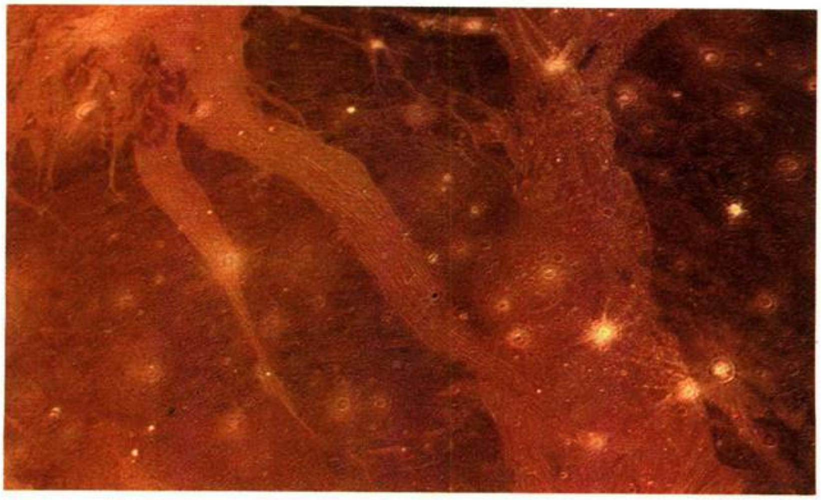
Beyond the expected science results, *Galileo* will undoubtedly uncover things about Jupiter that will throw a monkey wrench into our current understanding of the planet. "We are going to learn one hell of a lot more about Europa this time," said Yeates. "The mechanisms at work that affect the resurfacing of the moon are not understood. We don't know what new results will occur until we arrive at the planet. But once we've finally studied the data, we'll say 'of course' as if we were expecting the exact information we



LIKE A CRACKED BILLIARD BALL, Europa's surface is scarred by numerous channels. Europa has a rocky interior and a substantial icy crust.



AN OLD FRIEND will transform into a new world when *Galileo* arrives at Jupiter. Scientists are wary of predicting what may be discovered, but they expect many new features will be discovered and current theories will be overturned.

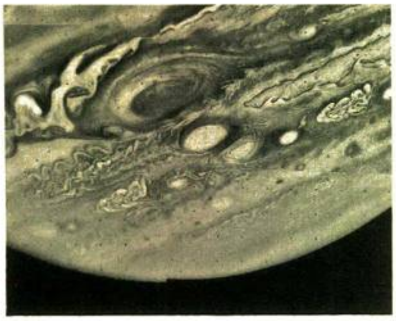


CLOSEUPS OF THE MOONS will show features like these craters, grooved bands, and fault fractures on Ganymede.

ended up with."

Yeates does say that the *Galileo* imagery from Ganymede will enlighten planetologists about the origins of "primal" versus "renewed" surfaces. Many scientists think some type of plate tectonics are active on Ganymede, providing the impetus to form the long rilles and grooves in the surface that were seen by *Voyager*.

"It's likely there are satellites embedded in the ring or near the planet that we didn't see in 1979," said Johnson. "Ground-based observations are often superior to space-based studies at detecting Jovian satellites. Also, we weren't as adroit at searching for very small moons at Jupiter as we were at Saturn and then Uranus and Neptune. Europa is a big unknown. I would be extremely sur-



GLOBAL SCIENCE AT JUPITER will take *Galileo*'s regional data and images and piece them together to form an overall picture of the planet.

"The final 150 days before planetfall is 'white-knuckle time' for the probe team." —Richard Young, probe science manager

prised if it turns out to be dull. It looks so strange in low-resolution photos that I know we are in for big surprises there. Europa may give us the opportunity to see icy volcanism taking place."

Johnson also feels there is an excellent chance of learning whether there is liquid water under the Europan ice crust. With three or four close passes by the moon, *Galileo* should settle the question. "If we see silicate crater rims jutting up through the ice on Europa, we'll know the ice is 100 meters thick, not 100 kilometers thick."

The possible types or quantities of any organic molecules in Jupiter's atmosphere will be a hotly debated issue. While no instruments similar to *Viking's* gas chromatograph/mass spectrometer are on the *Galileo* probe to look for certain organic molecules, *Galileo's* neutral mass spectrometer will look for specific molecules.

Rich Young predicts we'll learn that the internal heat of Jupiter, not the heat exchanged by water vapor, drives the winds and alternating colored zones in the Jovian atmosphere. "The question is how far below the upper ammonia cloud levels do the winds exist," Young said. "I think we will find them all the way down to the point where the probe goes 'crunch' at the 25 bar pressure level, about an hour after entry."

Another question centers on the depth and quantity of the theorized water clouds on Jupiter. Most post-*Voyager* models predict such clouds deep in the atmosphere. Any less-than-predicted quantities of water will cause a basic revision of the solar nebula theory of planetary composition. As Jim Pollack put it: "We will be removing four or five veils from the face of Jupiter with the probe. First the upper aerosol layer, then the ammonia cirriform clouds, the hydrogen sulfide and ammonia layer, and finally the water cloud level. No one knows exactly where and how thick that layer is. The water should be there somewhere. If it's not, or if it's very sparse, look out."

This sentiment is shared by Young. "A lesser quantity, or absence all together, of Jovian water clouds raises two questions: Did Jupiter ever have more water than it has now, and if so, where did the water go and how was it lost?"

Don't Bug Me

Perhaps the most debated public issue in the mission, next to the use of *Galileo's* nuclear-powered RTG system, is that of planetary contamination of Jupiter by the probe. Unlike the twin *Viking* landers sent to Mars in 1976, *Galileo's* probe is not biologically sterile. Many amateur experts and environmentalists have protested this lack of "interplanetary diplomacy." Letters have been sent to JPL voicing concern about the possibility of contaminating another world with our bugs despite the fact that Jupiter has no actual surface or any bodies of standing water or sources of food to nourish any terrestrial "beasties" that the probe might carry to Jupiter.

A detailed policy for planetary quarantine, drafted in 1984 by NASA and adopted by the agency for all planetary missions, states that "the conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. Therefore, for certain space-mission/target-planet combinations, controls on contamination shall be imposed." The policy established five categories of target-planet/mission-type requirements for any planetary protection. The basis on which the categories were established reflected the extent of robotic exploration of the solar system by 1983. A mathematical model developed to state the likelihood of planetary contamination states that the probability of contamination is a function of the initial microbial burden of the source at launch, the probability of surviving the vacuum and temperature of space and exposure to ultraviolet space radiation, the probability of arriving at the planet and surviving atmospheric entry, and the probability of microbe release and subsequent growth.

The policy analysis states that except for Mars and Saturn's largest satellite, Titan, the probability for all bodies in our solar system is either zero or approximately one in 100 trillion. A revision of the study claims that even those odds probably overstate the chances of contamination. According to the study, Jupiter is a "Category 2" planet, one requiring only modest precautions and no sterilization procedures whatsoever. *Galileo's* probe will eventually drop to a depth in the Jovian atmosphere where it is crushed and sterilized. Any hitchhiking earthly germs will not find a welcome mat waiting for them. The question of planetary contamination does not seem to bug the project scientists, however.

Having heard from four of the leaders of the *Galileo* science team, it is easy to see why they are so enthusiastic about this project. Despite the agonizingly long wait, things are about to start happening at a dizzying pace for the mission. "After so many years, it finally is a lot of fun to say you are a part of this project," said Rich Young. "It's about time." □

Joel K. Harris is the former project information coordinator for Galileo at the Jet Propulsion Laboratory in Pasadena, California. He is currently director of Twilight Tours, a company that organizes astronomical and science expeditions based in Burbank, California.

Radar Reveals a Double Asteroid

When asteroid 1989 PB flew through the beam of the Arecibo radio telescope, radar astronomers found the first direct evidence for asteroids with double shapes.

by Steven J. Ostro

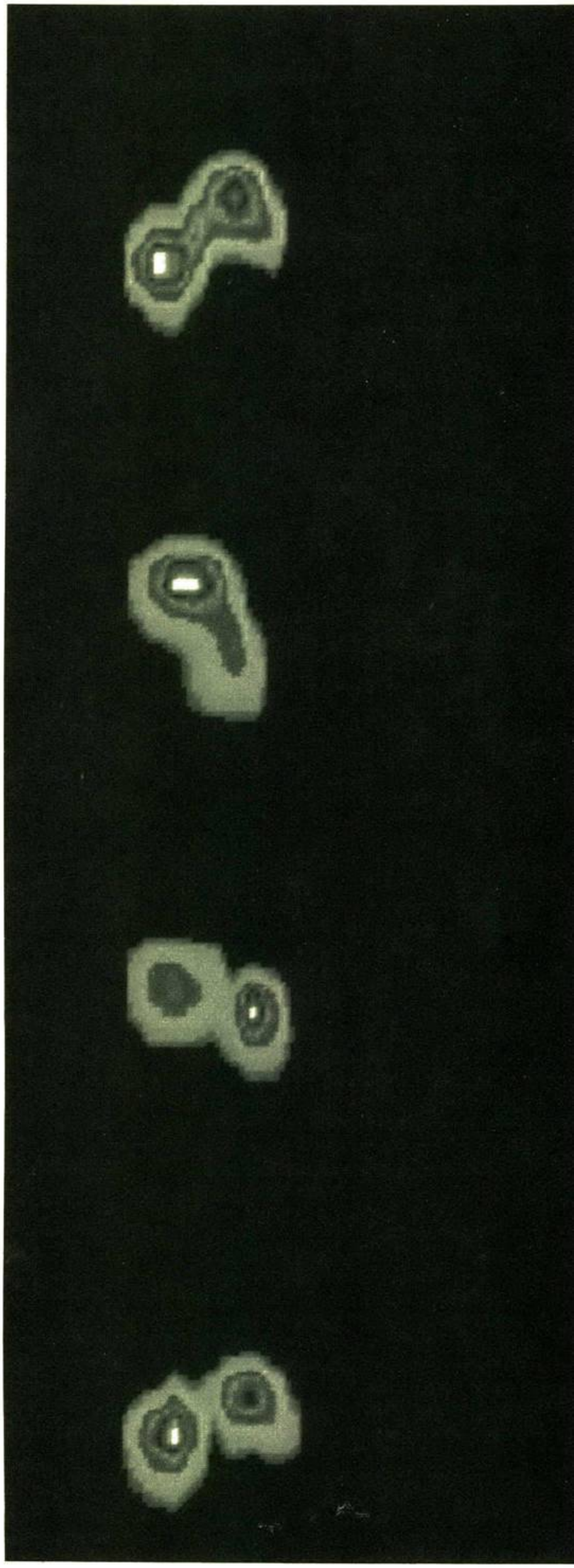
On August 22, 1989, the newly discovered asteroid 1989 PB passed through the beam of the 1,000-foot radio telescope at Arecibo, Puerto Rico. When it did, our team of astronomers — John Chandler and Irwin Shapiro of the Center for Astrophysics, and Alice Hine of the Arecibo Observatory — were ready. We had been tracking 1989 PB for the previous few days using the giant antenna as a radar dish. Then, knowing exactly where the fast-moving object was going to be, we took dozens of radar "photos" of the asteroid as it flew by at a distance of 3.5 million miles.

The observations show with unprecedented detail that this near-Earth asteroid is a remarkable object. About a mile long and half a mile wide, 1989 PB has a double-lobe shape consisting of two irregular chunks of rock, each about half a mile in diameter. The two objects are most probably touching, though it is also possible they are separate objects orbiting a common center of mass.

To read the images correctly, imagine that you are looking down on 1989 PB's north pole. The Arecibo radar meanwhile is shining from the top of the page in the plane of the paper. Because the telescope serves as both transmitter and receiver, the part of the asteroid that lies closer to the antenna (the top of the page) will reflect the signal more strongly and thus look brighter. In some images (the right-hand one in the top row, for example), the farther lobe lies partially behind the closer lobe from the antenna's viewpoint, and therefore it appears smaller and less reflective. Slowly whirling in the radar beam, 1989 PB takes about four hours to rotate once.

The images do not reveal any details smaller than about 1,000 feet across. But over the coming year, computer processing and analysis will let us produce a three-dimensional portrait of the asteroid. As far as we can tell, apart from its double nature, 1989 PB looks no different than any other class S (stony) asteroid we have observed.

Compound, bifurcated, or binary asteroids have long been hypothesized by astronomers, who based their suspicions on observations of asteroid/star occultations or on the way an asteroid's brightness changes as it tumbles in space. Until now, however, convinc-



ASTEROID 1989 PB rotates in a series of images taken every nine minutes. The sequence runs left to right, top to bottom.

BY 1993 the 1,000-foot radio telescope at Arecibo, Puerto Rico, will be able to make radar pictures of asteroids with six times the sharpness possible now.

ing observational evidence was lacking. What's ironic is that 1989 PB is the first asteroid for which astronomers have actually obtained a high-quality radar picture — and the object turns out to be double-lobed!

What this says about other near-Earth asteroids is anyone's guess. One plausible explanation for how compound asteroids might occur was devised by William Hartmann of the Planetary Science Insitute in Tucson. His theory involves catastrophic collisions between two large asteroids of similar size. If conditions were right, the theory says, two large pieces might emerge from the collision with only small velocities relative to each other. Responding to their mutual gravity, they could then either go into an orbit around a common center of mass or end up touching. It is also possible that such collisionally generated objects might be more apt to wind up in Earth-crossing orbits.

1989 PB has a 400-day-long year as it travels from beyond the orbit of Mars to inside the orbit of Venus. It was discovered on August 9 — just thirteen days before our observations — by Jet Propulsion Laboratory astronomer Eleanor Helin and her colleagues on photographs taken with the 18-inch Schmidt camera at Palomar Mountain.

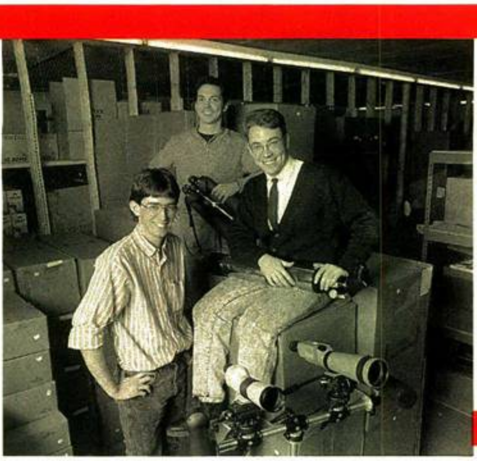
With any radar observation of an asteroid or planet, you need to know very precisely where the object is and getting an accurate position ephemeris for a newly discovered, fast-moving object is always a frantic experience. Luckily, some prediscovery photos of 1989 PB were found and a good ephemeris was quickly computed.

A second, really fantastic piece of luck was that PB was coming along with a right ascension just behind the asteroid we were scheduled to observe, 12 Victoria. We hardly needed to perturb the telescope schedule at all to squeeze in observations of 1989 PB. The images here are taken from our last and best looks at the object, on August 22.

The 1989 PB experiment was highly successful, but there are much better things to come. Between now and 1993 the Arecibo telescope will be upgraded, which will improve its sensitivity about twenty times. The upgrade will also substantially improve the data-taking hardware and software. By 1994 I hope to be imaging at least one or two near-Earth objects per year with resolutions of 150 feet or better.

One of the key questions for us to examine is whether double-lobe asteroids like 1989 PB are beautiful but exotic oddities or relatively common. A decade of observations with the improved Arecibo radar might give us an answer. ☐

Steven J. Ostro is a scientist at the Jet Propulsion Laboratory specializing in the study of asteroids and planetary satellites with radar.



Annual Warehouse Clearance Sale

We've cleaned the warehouse to make room for the new Meade Premier Series telescopes. Now Meade telescopes and accessories...plus Telerad finders and selected books are priced to move. Savings like these come but once a year...and are good only while supplies last.

Ask about our new Telescope Buying Guide...it's free!

Meade Telescope Clearance Prices

while supplies last

DS-16A with steel bearings (Shipped truck freight collect)	**$1999**
2120 LX5	from **$1599**
2120 LX3	from **$1499**
2120 GEM	**$1299**
2080 LX5	**$1499**
2080 LX3	**$1299**
MTS-SN8 with LX3 drive	from **$995**
MTS-SN6 with 788 drive	**$695**

Meade Accessory Specials

106C off axis guider	$149
1A dust seal	$45
wide field adapter system	$119
905 variable polarizer	$45
1.25'' eyepiece holder	$29
62 camera adapter	$35
36 hand control for MTS	$89
66A manual declination for MTS	$49
38M declination motor for MTS	$89
39 declination motor for LX6	$89
712 dew shield for 8''	$59
710 dew shield for 10''	$89
43 varipak drive corrector for SCT	$99
Series 6 filter set	$59
1200A focus motor	$159
928 45° erecting prism	$49
924 porro prism	$49
accessory shelf	$29
.965 to 1.25'' adapter AD2	$24
419 illuminated reticle eyepiece	$89
427 illuminated reticle eyepiece	$89
122 2x barlow	$49
Any 1.25'' screw-in color filter	$15
908 screw-in nebula filter	$79
basic camera adapter	$35
917 hybrid diagonal	$49
tele-extender	$35
variable projection camera adapter	$53
piggyback bracket for Schmidt-Cassegrain	$39

Meade
Tube Balance System
for 2080 & 2120
clearance sale price
$79

Prices subject to change.

Selected Book Savings

Add $3 shipping for book-only orders.

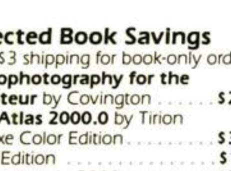
Astrophotography for the Amateur by Covington	**$27.95**
Sky Atlas 2000.0 by Tirion	
Deluxe Color Edition	**$39.95**
Field Edition	**$15.95**
Uranometria 2000	**$39.95**
Atlas of Deep Sky Splendors	**$49.95**
Norton's Star Atlas	**$21.95**
Burnham's Celestial Handbooks each	**$12.95**
set of 3 volumes	**$34.95**
Messier Album	**$16.95**
Sightseeing (NASA archive photos)	**$24.95**

TELRAD FINDER
$42.95

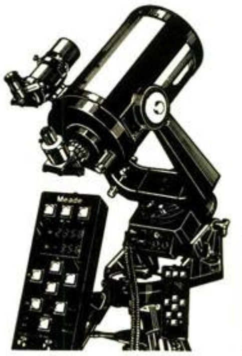
Meade Schmidt Special

2080B $1199

For a limited time, Meade has provided us with a small number of 2080B, basic 8'' Schmidt-Cassegrain telescopes. National Camera offers them to you at significant savings. Hurry...supplies are limited!



Super Special
Meade 224 refractor
only
$129



Authorized Meade Dealer

BUY A NEW
MEADE PREMIER
SCOPE AND GET
$1000 OFF
SELECTED
ACCESSORIES!

Meade Premier Series Explained

We've been flooded with inquiries about the new Meade Premier Series telescopes, and their advantages over previous lines.

In an effort to more easily serve a wide range of astronomical enthusiasts, Meade Instruments is restructuring its telescope line. Meade has advertised the new Premier Series with complex charts. However, the concept is simple. The LX6 drive, one of the most sophisticated electronic drives commercially available, will now be standard on all Meade Schmidt-Cassegrain telescopes.

The 30, 50, and 70 series refer to the accessories which come as standard equipment. The 30 series includes a 6x30 straight finder for 8-inch scopes or 8x50 for 10-inch scopes; plus a 1.25'' diagonal and 25mm modified achromatic eyepiece. The 50 series includes a 9x60 polar illuminated finder, a 2'' mirror diagonal, a 26mm super Plossl, and the electronic command center for drive correction. The 70 series includes everything that the 50 series does, plus the Meade computer aided telescope system, digital readout system, and #39 declination motor all factory installed. It also comes with 1200A electric focus, off-axis guiding system, and three aditional eyepieces...6.7mm ultra-wide, 14mm ultra-wide, and 40mm super-wide.

All Premier Series telescopes are available with either an f/10 or f/6.3 focal ratio. In addition, the 10-inch models offer the option of the Meade Super Wedge.

All you really need to know is what you'd like to do with your new telescope. We'll ask the right questions to direct you to the right equipment. And when you order from the Meade Premier Series, Meade and National Camera will give you $1000 directly off invoice on selected accessories. Call toll-free today for more details, and discover the heavens with a new Meade telescope.

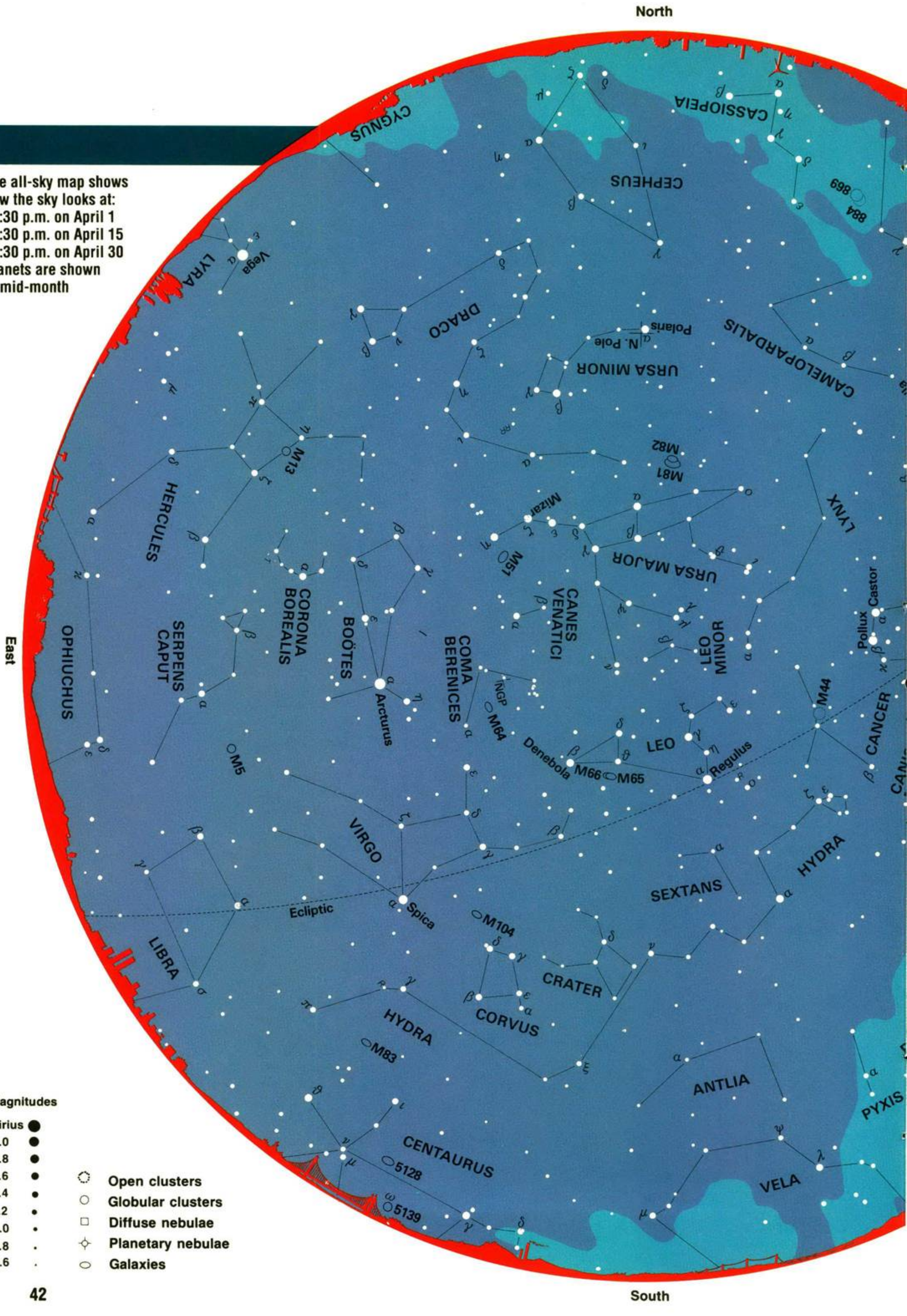
Since 1914

National Camera Exchange

9300 Olson Highway, Golden Valley, Minnesota 55427. For information, call our telescope experts at (612) 546-6831. Open Monday-Friday 9am-8pm, Saturday 9am-5pm, Sunday noon-5pm. Our prices include standard UPS shipping and handling within 48 states. No additional charge for VISA, MasterCard, Discover Card. We offer a 30-day money-back guarantee, and full factory warranties. Please call for instructions before returning merchandise.

TO ORDER CALL TOLL-FREE 1-800-624-8107

The all-sky map shows how the sky looks at:
10:30 p.m. on April 1
9:30 p.m. on April 15
8:30 p.m. on April 30
Planets are shown at mid-month


North
South
East
CYGNUS
CASSIOPEIA
CEPHEUS
LYRA
Vega
DRACO
Polaris
N. Pole
URSA MINOR
CAMELOPARDALIS
M82
M81
M13
HERCULES
Mizar
M51
URSA MAJOR
LYNX
CANES VENATICI
CORONA BOREALIS
BOÖTES
COMA BERENICES
NGP
M64
SERPENS CAPUT
OPHIUCHUS
Arcturus
LEO MINOR
Castor
Pollux
M44
CANCER
LEO
Denebola
M66
M65
Regulus
M5
VIRGO
HYDRA
SEXTANS
Ecliptic
Spica
M104
LIBRA
CRATER
CORVUS
HYDRA
M83
ANTLIA
PYXIS
CENTAURUS
5128
5139
VELA
869
884

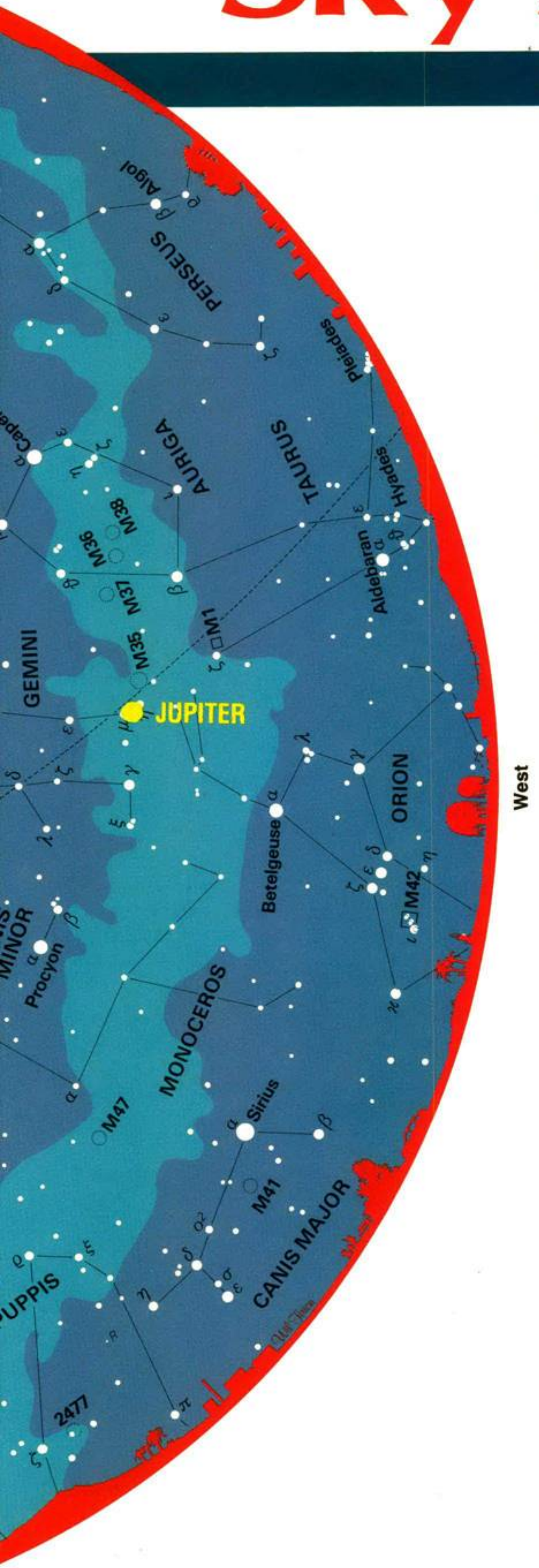
Magnitudes

- Sirius ●
- 0.0 ●
- 0.8 ●
- 1.6 •
- 2.4 •
- 3.2 •
- 4.0 •
- 4.8 ·
- 5.6 ·

- ⛶ Open clusters
- ○ Globular clusters
- □ Diffuse nebulae
- ⌖ Planetary nebulae
- ⬭ Galaxies

Sky Almanac

April 1990



LOOK FOR COMET AUSTIN

Comet Austin appears impressive in the morning sky in late April. This first-time visitor to the inner solar system is expected to shine at second magnitude or brighter, which will make it obvious to the naked eye as it climbs steadily higher in the eastern predawn sky with each passing day.

MERCURY BRIGHT IN THE EVENING

Mercury's best apparition of 1990 occurs in the western evening sky during April. The innermost planet is farthest from the Sun and highest in the sky on April 13, but it is fairly easy to spot about forty-five minutes after sunset during the first three weeks of April.

A SLENDER CRESCENT MOON

Observers throughout North America can see a Moon less than one day old on the evening of April 25. Look for the young Moon's thin crescent low in the western sky shortly after sunset that night.

LYRIDS PEAK ON APRIL 22

The Lyrid meteor shower peaks in the early morning hours of April 22. You can expect to see ten to fifteen bright, moderately fast meteors per hour before dawn breaks that day.

Dates and Times

1 The Moon passes 3° north of Jupiter, 2 p.m. EDT

2 First Quarter Moon is at 6:24 a.m. EDT

9 Comet Austin is at perihelion
Full Moon is at 11:18 p.m. EDT

12 The Moon is at apogee (252,301 miles from Earth), 4:31 p.m. EDT

13 Mercury is at greatest eastern elongation (20°)

14 The Moon passes 0.1° north of Antares, 3 a.m. EDT

17 The Moon passes 1.8° south of Saturn, 9 p.m. EDT

18 Last Quarter Moon is at 3:02 a.m. EDT

20 The Moon passes 3° north of Mars, 4 p.m. EDT

21 The Moon passes 4° north of Venus, 9 p.m. EDT

22 Lyrid meteor shower peaks
Hebe is at opposition

25 New Moon is at 12:27 a.m. EDT
The Moon is at perigee (222,142 miles from Earth), 12:51 p.m. EDT

29 The Moon passes 3° north of Jupiter, 4 a.m. EDT

Eye on the Sky by Deborah Byrd

COMET AUSTIN BRIGHT IN THE MORNING

The brightest comet in over a decade should put on an impressive show in the morning sky during the last ten days of April. Comet Austin is expected to shine at 2nd magnitude or a bit brighter, which is as bright as the stars of the Big Dipper. To find Comet Austin you'll need to get up early and be outside by the time morning twilight begins. Look for a diffuse glow lying 15° to 20° above the northeastern horizon (to the left of the bright predawn planets), with a tail pointing nearly straight up from the horizon.

The last ten days of April is the first of two excellent, Moon-free observing windows for Comet Austin. During May the comet rises progressively earlier and should shine at around 3rd magnitude. In the last half of May Austin rises before midnight and is more than 50° above the horizon at the start of morning twilight.

As with any comet, you will see Austin best from a dark-sky location. And binoculars will add substantially to the view with your naked eye. (For more details on observing the comet, see "Get Ready for Comet Austin" on page 70.)

Astronomers have a rule of thumb that says bright comets arrive about once a decade, but we haven't had a really spectacular one since Comet West in 1976. Unfortunately, few people saw that one because they were turned off to comets by the disappointing apparition of Comet Kohoutek a few years earlier. Kohoutek is a classic illustration of how inexact predictions of a comet's brightness can be, and there's no guarantee that Comet Austin will be as bright as predicted. Still, there is every indication that Austin will be well worth watching.

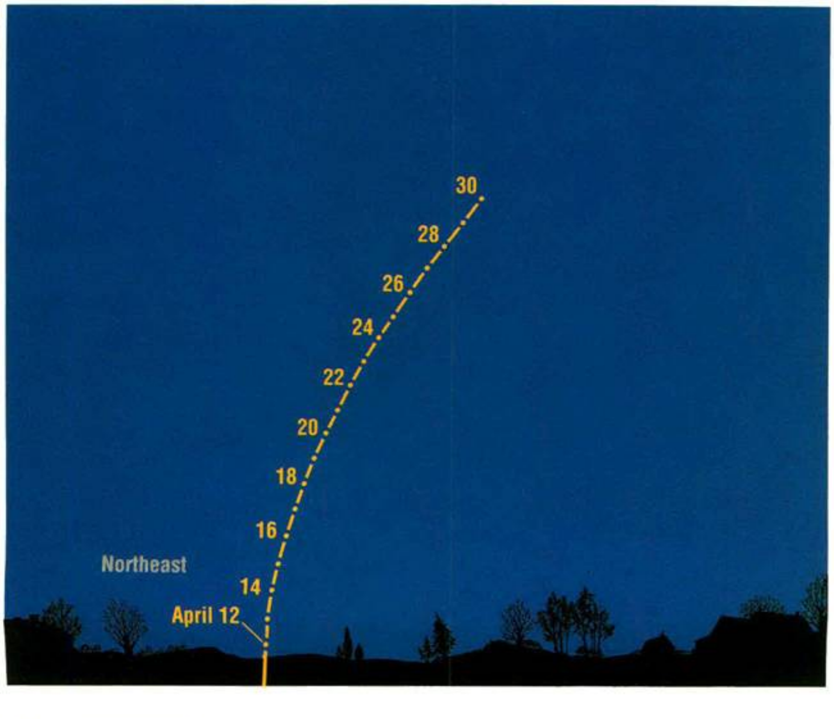
MERCURY AT ITS BEST

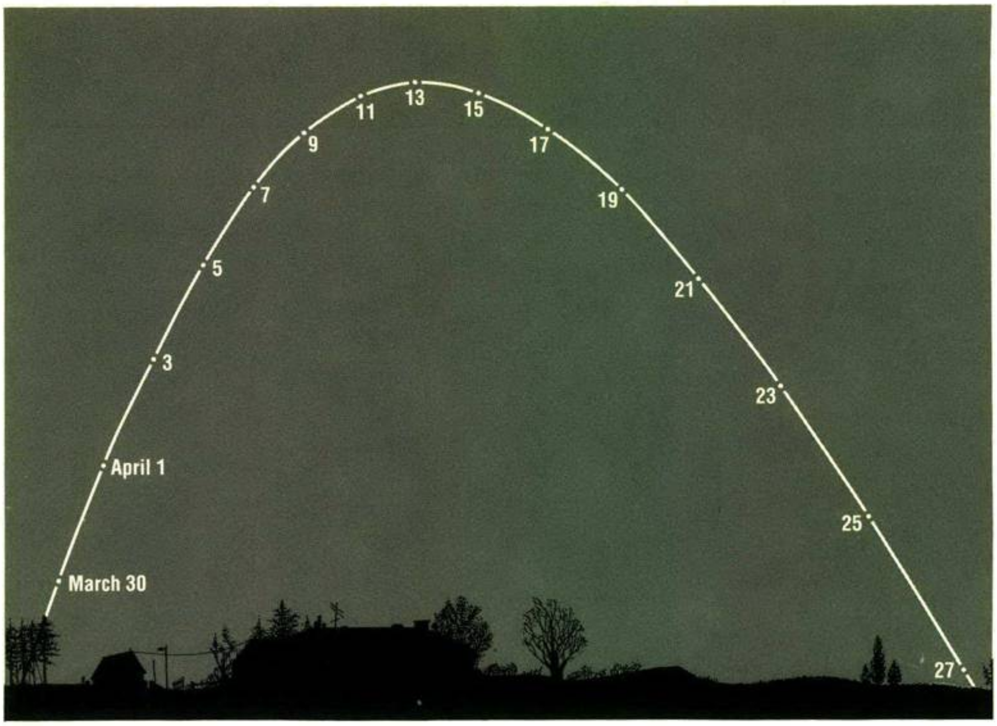
Mercury puts on its best show of 1990 during the first three weeks of April. Look for the innermost planet low in the western sky thirty to forty-five minutes after sunset. The planet's greatest elongation is on April 13 when Mercury lies 20° east of the Sun. Because the ecliptic — the approximate path of the planets across the sky — stands nearly straight up from the western horizon on April evenings, Mercury's elongation from the Sun translates almost entirely to altitude above the horizon.

Mercury has a reputation for being elusive. The planet orbits closer to the Sun than any other planet, which means it never appears far from the Sun and can only be glimpsed against a twilight sky. Only a small fraction of the population has ever seen it. Even the great astronomer Nicolas Copernicus, whose insights about the night sky helped remove Earth from the center of the universe, is said to have never seen this tiny planet.

And yet Mercury is far brighter than most stars. At greatest elongation it shines at magnitude 0.1 and it is slightly brighter than that earlier in April. With a little effort and perhaps the aid of a pair of binoculars you should be able to spot the elusive planet quite easily this month.

COMET AUSTIN becomes easy to see toward the end of April as it climbs higher into the predawn sky. Look for the 2nd-magnitude comet above the northeast horizon as twilight begins to break.





THE EVENING "STAR" this month is Mercury, which makes its best appearance of 1990 in April. At its peak on April 13, the innermost planet lies 10° above the western horizon forty-five minutes after sunset.

SEARCH FOR THE YOUNG MOON

The steep angle of the ecliptic to the western horizon this month also makes this a good time to search for the young Moon. A young Moon is a very slender crescent Moon that appears immersed in the twilight glow low in the west a day or so after New Moon.

If you live in the contiguous United States, the evening of April 25 offers an excellent opportunity to see a young Moon. On the East Coast the Moon is only 20 hours old 30 minutes after sunset, while on the West Coast the Moon is still a very young 23 hours old. To see it you need to have a clear, unobstructed western horizon. Begin searching right after after sunset. Binoculars can help you find the young Moon, but if your sky is clear you should have little trouble seeing it with your naked eye.

APRIL'S PLANETS

Brilliant Jupiter shines high in the west on April evenings. The –2.1-magnitude planet lies in Gemini, surrounded by the brilliant winter stars. In early April Jupiter lies about a degree away from the star cluster M35. The two form a pretty pair viewed through binoculars.

Saturn has ended its apparent game of tag with the other bright predawn planets. Appearing higher in the southeast at the start of each new day, the ringed planet grows more prominent in the morning sky. The 0.6-magnitude planet remains in Sagittarius during April, but it is moving away from the Teapot asterism and toward the Arrowhead asterism in Capricornus.

Orange-red Mars rises about two hours before the Sun and stands low in the southeast at sunrise, about 20° below and to the left of slightly brighter Saturn when April begins. However, with Saturn rising progressively earlier and Mars seemingly rooted to its spot above the predawn horizon, the two planets appear nearly twice as far apart by month's end.

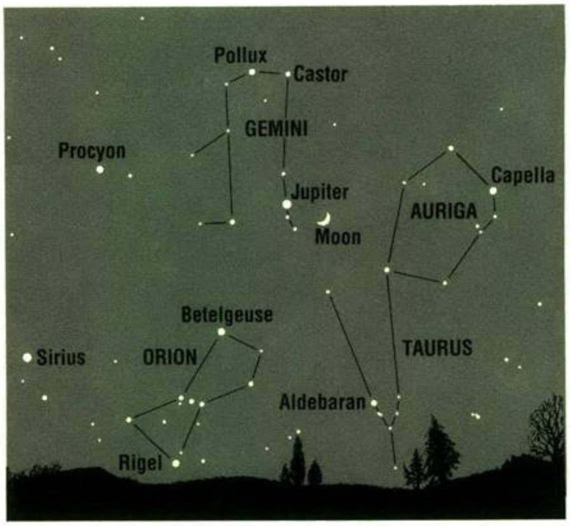
In fact, Mars is moving rapidly eastward in front of the stars. That's why it stays low in the east at dawn, while the stars rise earlier each day and so slide by it. The Red Planet begins April in Capricornus, but before mid-month it shifts into Aquarius.

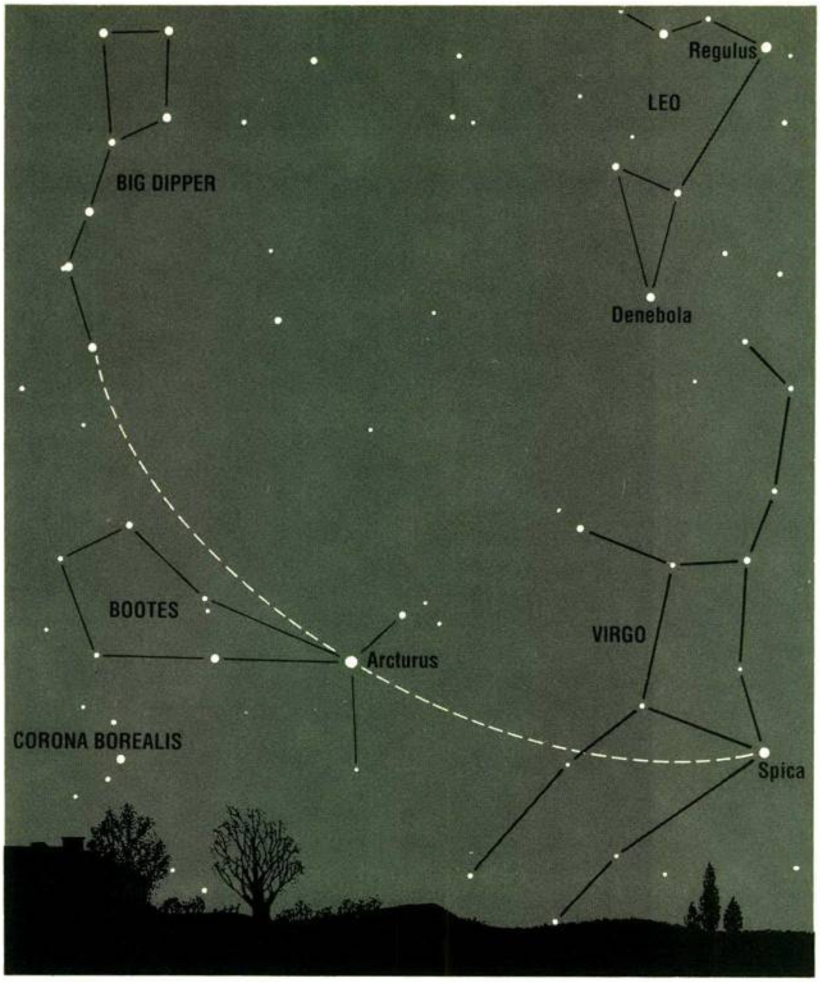
Venus shines brilliantly in the eastern predawn sky where it lies to the lower left of Mars. Venus was at greatest elongation from the Sun at the end of March and is now sinking closer to the Sun once again.

Unfortunately, the planet did not reach a high altitude at greatest elongation and it remains low in the sky for the rest of this morning apparition. Venus is never disappointing, however, because it shines so brightly. In April Venus shines at magnitude –4.3.

This month's morning sky is quite different from the predawn sky of February and March. Venus, Mars, and Saturn spent those months shifting their relative positions. Now these three bright planets are strung out along the ecliptic before dawn. By extending the line between them, you can get a rough idea of the plane of the solar system. Be sure to watch the morning sky between April 18 and 22 as the

JUPITER AND THE MOON lie just 3° apart on the evening of April 28.





DRIVE A SPIKE TO SPICA after you follow the arc of the Big Dipper's handle to Arcturus and you'll easily find the 1st-magnitude luminary of Virgo.

Moon makes its monthly sweep through this part of the sky and passes each planet in turn.

APRIL'S STARRY SKY

You can use April's Full Moon to locate Spica, the brightest star in the constellation Virgo. The Moon passes near this star on the night of April 9/10.

You don't need the Moon to find Spica, though. It's easy to find on any spring evening if you recall the old saying, "Follow the arc to Arcturus, and drive a spike to Spica." Just draw an imaginary line out from the curve of the handle of the Big Dipper, which is now high in the northeast each evening. The orange-tinged star Arcturus, in the constellation Bootes, lies about 30° from the end of the handle. Spica lies about another 30° farther on.

Virgo is a large and rather dim constellation, the longest of the twelve zodiacal constellations. Spica stands out from this grouping, a blue-white star shining at 1st magnitude. It is often considered a classic example of a 1st-magnitude star, although the truth is that Spica varies a bit in brightness.

One hundred years ago astronomers discovered that Spica had a stellar companion. The two stars in the Spica system are much larger and far more luminous than our Sun, yet they whirl around one another in only a little more than four days. A third star in the Spica system, this one a 12th-magnitude star, lies over 2' from the other two.

Spica has a rich mythological legacy. The name is often translated as "an ear of wheat," said to be held in the hand of Virgo, the Maiden. This constellation has long been associated with Earth goddesses and, in the Northern Hemisphere, with the coming of spring.

To the ancient Greeks, Virgo was associated with Demeter, the goddess of fruitfulness. One of the more interesting myths about her concerns Persephone, her daughter. The god of the underworld, Hades, fell in love with Persephone. However, not wanting her daughter to leave her for a new home below the ground, Demeter refused to allow them to marry. Eventually, Hades' passions got the best of him. He swept Persephone away in his black chariot and took her to the underworld to live.

Demeter roamed around searching for her daughter, neglecting her duties as Earth goddess. A famine hung over the land until the king of the gods, Zeus, forced Hades to let Persephone go. Because she had eaten six pomegranate seeds while in the underworld, she could not return to her mother permanently. She would spend six months with her husband and then six months with her mother.

According to the legend, when Persephone spends her six months in the underworld, the Earth goddess Demeter grieves, and we have winter. When Persephone comes back to Mount Olympus, joy returns to the goddess and, to the delight of all, spring arrives.

Through the Eyepiece by Rick Shaffer

A BRIGHT MORNING COMET

Northern Hemisphere observers have been waiting several years for a bright, well-placed comet to make its way into the inner solar system. It appears that the wait is now over. Comet Austin should be as bright or brighter than any comet in the past fourteen years and it is favorably positioned for observers throughout the Northern Hemisphere. (See "Get Ready for Comet Austin," page 70.)

Comet Austin reaches perihelion (its closest approach to the Sun) on April 9 and should be at its brightest around then. Unfortunately, during that time it is very low in the evening sky just after sunset and is extremely hard to see. During the first ten days of the month the comet is expected to shine at 1st magnitude or brighter. However, on those days Austin lies only about 6° above the west-northwestern horizon at the end of nautical twilight, when the sky has become dark enough for most naked-eye stars to become visible, for observers at 40° north latitude. It is highly unlikely that anyone will overcome the low elevation and twilight sky to get a good view of the comet at this time.

But by the middle of April Comet Austin starts to shoot up in the morning sky, gaining altitude with each passing day. Most observers at mid-northern latitudes will get their first good look at the comet during the last half of April. You might catch a glimpse of it as early as the morning of the 15th when it is 5° above the northeastern horizon as nautical twilight begins. Five days later the comet is 12° above the horizon at the beginning of twilight and should be quite easy to see; by the 30th Austin is a full 25° above the horizon. With New Moon occurring on April 24/25, the last ten days of April should be great for observing Comet Austin.

The highlight of the late April observing window is the comet's close passage by the Great Andromeda Galaxy (M31). Austin passes 5° south of the galaxy on April 25 and the two are within 6° of each other from the 22nd to the 27th. This is a great photo opportunity for all astrophotographers. If you own a 35mm camera your best bet to capture the scene is probably a 135mm lens. If the comet's tail is longer than expected, however, you may need a wider-angle lens to capture it all. Fast film (ISO 1000 to 3200) and exposures as short as 30 seconds should be enough to capture the comet. Be willing to experiment and make sure to take lots of photos.

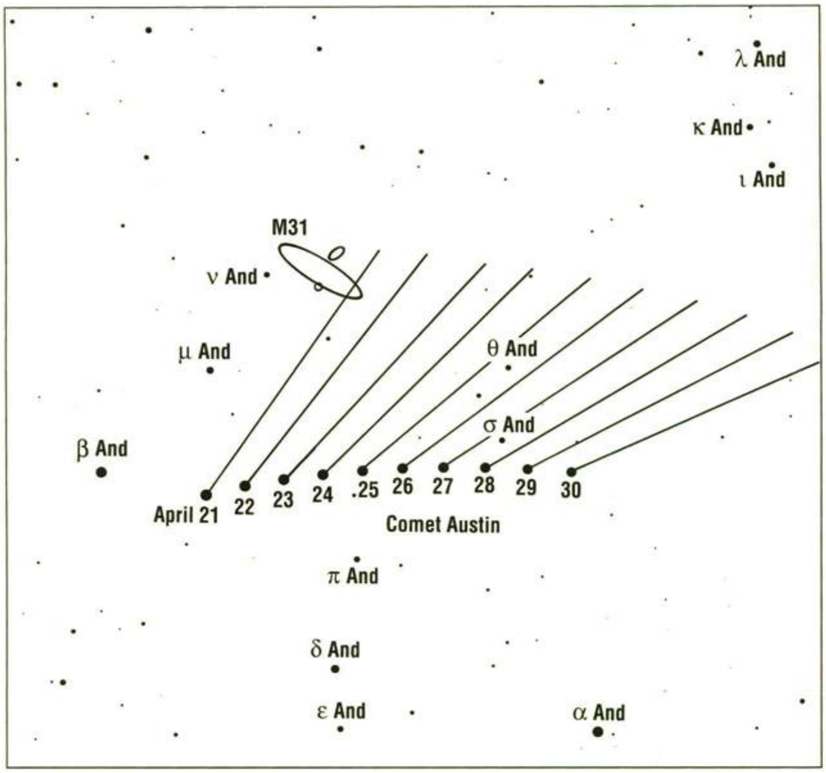
Unfortunately, there is no totally accurate way of predicting how bright Comet Austin will be. A rough average of the brightness estimates that have been made so far would suggest that the comet will reach 1st magnitude at perihelion, fade to 2nd magnitude by the last week of April, and remain fairly constant at about 3rd magnitude for most of May. The more optimistic predictions expect Austin to be one or two magnitudes brighter than that, while the more conservative estimates put it one or two magnitudes fainter.

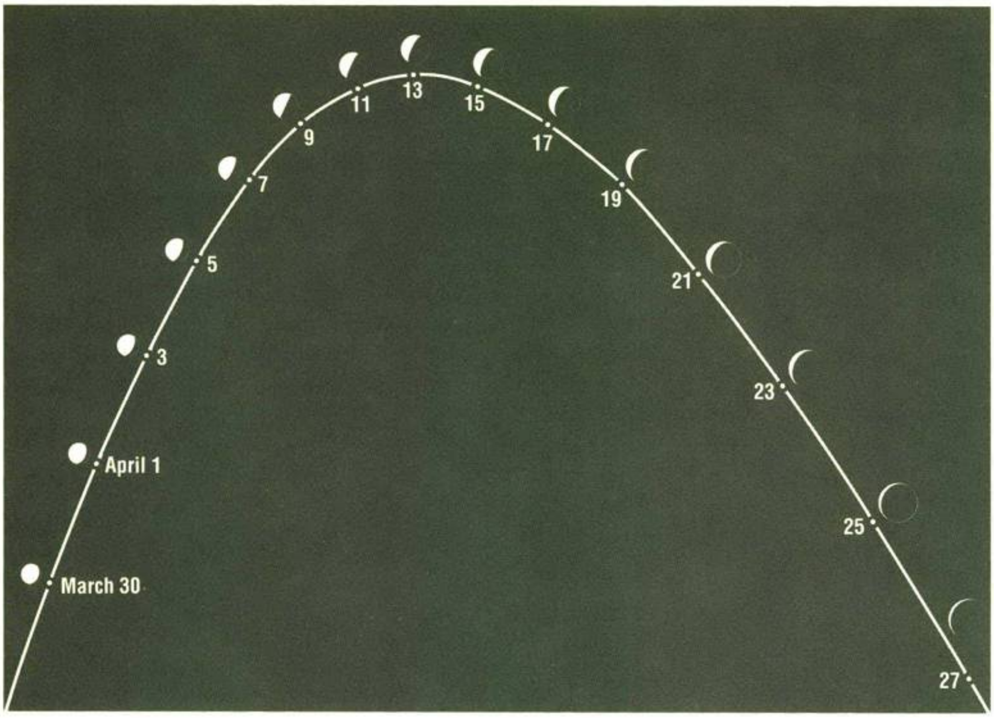
The first step in observing

COORDINATES FOR COMET AUSTIN

Date	R.A. (2000)	Dec.
April 1	1h49.2m	15°01'
April 4	1h48.7m	19°13'
April 7	1h45.8m	23°21'
April 10	1h39.7m	27°10'
April 13	1h30.6m	30°22'
April 16	1h18.9m	32°49'
April 19	1h05.7m	34°30'
April 22	0h51.4m	35°32'
April 25	0h36.4m	36°02'
April 28	0h20.7m	36°04'
May 1	0h04.0m	35°41'

M31 GETS A VISITOR in late April when the nucleus of Comet Austin passes 5° from the galaxy. Positions are shown at 6 a.m. EDT (5 a.m CDT, 4 a.m. MDT, 3 a.m. PDT). Tail length may vary considerably.





WATCH MERCURY GROW in your telescope's eyepiece while its phase shrinks during April's evening apparition.

Comet Austin, especially in the period just after perihelion, is to find the best observing site you can. The site must have an unobstructed horizon to the east and northeast. If you choose a seashore or lakeshore, make sure you can clearly see stars as they rise. Pay less attention to selecting a site with good seeing conditions; the most important factors are a low horizon and good transparency.

Next, arrive at your site no later than about 4:30 a.m. daylight time if you're observing during the week of April 15. In the last week of April you'll want to arrive even earlier than that. This gives you forty-five minutes to get thoroughly dark adapted. If you can, arrive at your observing site even earlier and either sleep or observe other celestial objects until the comet rises.

The first feature of Comet Austin you're likely to see is its tail. If Austin has a bright ion tail, it will appear long and thin and might resemble a faint searchlight shining up from the horizon. Because the ion tail points away from the Sun and the Sun is due south of the comet at mid-month, the tail points north. Over the next two weeks the tail points more to the northwest and appears almost perpendicular to the horizon. With this geometry you may be able to see the tail thirty minutes or more before the time the head of the comet rises.

Starting at an azimuth of about 45°, pan toward the south until you've reached due east (azimuth 90°). If during this pan you detect even a hint of the comet's tail, confirm it by rapidly panning your glasses back and forth over the suspected area. This should confirm the presence of the tail because the human eye can detect faint objects better if they are moving rapidly through the field of your vision than if they are moving slowly or standing still. As the comet climbs higher its tail may appear a bit more distinct as it leaves behind the gloom near the horizon. However, during April at least, it's fighting a losing battle as the sky brightens before sunrise.

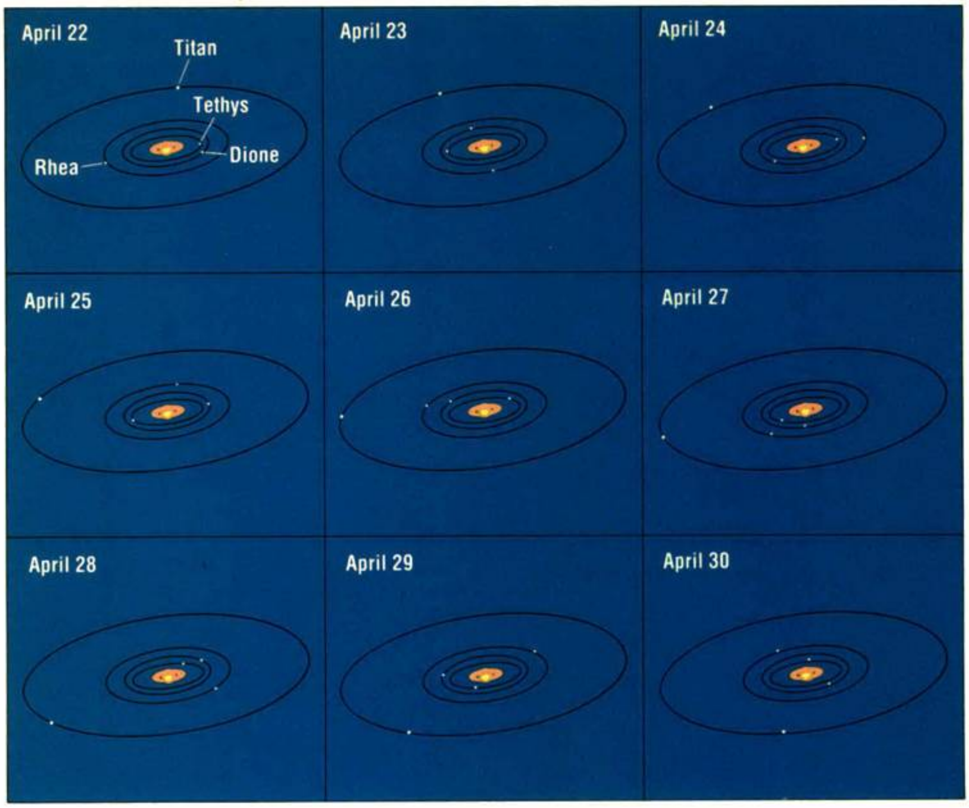
That sky brightness may effectively hide much of the tail during the first week to ten days after perihelion. However, you should still be able to see the head, or coma, of Comet Austin at about 5:40 a.m. local daylight time on April 15. It will appear earlier every morning thereafter. Use the early part of the viewing window to examine what you can of the tail while the contrast is at its highest, then examine the coma of the comet with your telescope using powers between 50x and 150x. If Austin is bright and active, there will be many changes visible from night to night.

MERCURY'S RAPIDLY CHANGING APPEARANCE

As if to give observers something to do in the evening, Mercury has a good evening apparition during the first part of April. This is easily the best evening apparition of the year — even better than September's morning apparition — so don't let Comet Austin deter you from paying Mercury some attention. Mercury reaches its greatest elongation east of the Sun on April 13, but it is visible from the beginning of the month to about April 25.

The most interesting aspect of Mercury's telescopic appearance over the three to four weeks of this apparition is its rapidly changing size and phase. On the 1st Mercury measures 5.7" across and its distinctly gibbous disk is 84-percent lit. The planet is half-lit and measures 7.1" across on April 10. At greatest elongation three days later the 40-percent-lit disk has an apparent diameter of 7.7". By April 25 Mercury's disk swells to 10.5" across and its phase shrinks to a slender, 9-percent-lit crescent.

Look for Mercury low in the western sky about forty-five minutes after sunset. At greatest elongation it lies 10° above the horizon on a line approximately one-third of the way from the horizon to the Pleiades.



SATURN'S FOUR BRIGHTEST MOONS are easy to find in a telescope if you know where to look for them. The satellites' positions are shown at 5 a.m. EDT (4 a.m. CDT, 3 a.m. MDT, and 2 a.m. PDT).

TELESCOPIC PLANETS

Venus begins the second half of its rather poor morning apparition this month, having reached greatest western elongation on March 30. In mid-April its slightly gibbous disk measures 20.7" across and shines brightly at magnitude –4.3. In the second half of April you can observe Venus after morning twilight washes out your view of Comet Austin.

Mars is about an hour of right ascension west of Venus, so it gives you another target to look at in the morning sky. Unfortunately, the Red Planet is not an especially interesting telescopic object this month. Its 1st-magnitude disk has an apparent diameter of less than 6", so it will be a few more months before you'll be able to see its surface markings very well.

Time is running out for observing Jupiter during this apparition. The giant planet sinks lower in the west with each passing evening. If you want to see any surface details, you'll have to look right after you finish observing Mercury. This month Jupiter shines at magnitude –2.1 and its disk measures 36" across its equator.

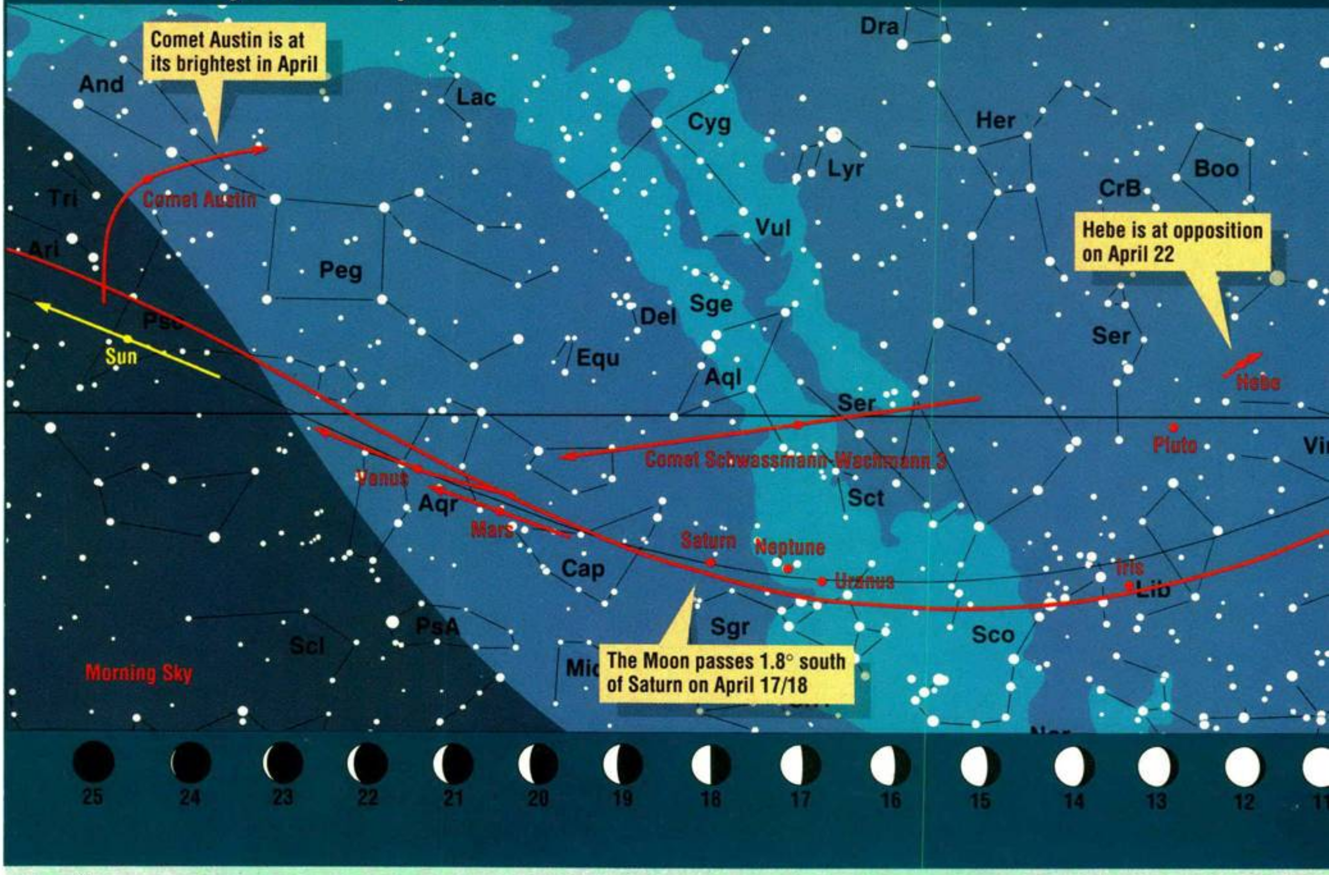
The outer gas giants are well-placed for observation this month. Saturn, Uranus, and Neptune all lie in Sagittarius high in the morning sky. If you get up early to view Comet Austin, the three planets make tempting targets while you wait for your eyes to get dark adapted.

Saturn is easily the highlight of the trio. Its 16.6"-diameter disk is encircled by the glorious 38"-diameter rings. The chart at the top of this page will help you locate Saturn's four brightest satellites at the end of the month when the Moon is out of the sky and the comet beckons you out in the early morning.

Uranus and Neptune have much less to offer than the other major planets. Uranus' blue-green disk measures 3.7" in diameter and shines at magnitude 5.7 this month. Neptune is an 8th-magnitude, blue-gray world that appears 2.2" across in your telescope's eyepiece.

Remote Pluto will reach opposition on May 7, so if you're eager to see the smallest and faintest planet in the solar system and relish difficult observing challenges, April is a good time to look. See "Hunting the Last Planet" on page 58 for a thorough discussion of this year's Pluto apparition. □

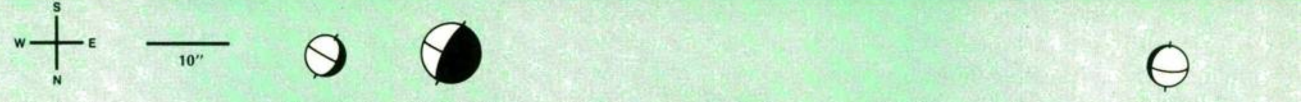
The Solar System April 1990

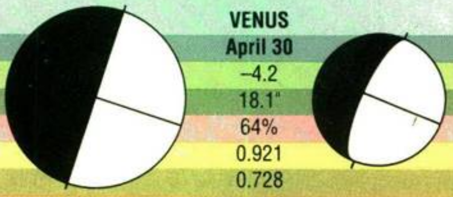

And
Tri
Ari
Psc
Sun
Comet Austin
Lac
Peg
Dra
Cyg
Lyr
Her
Vul
Sge
Del
Equ
Aql
Ser
Comet Schwassmann-Wachmann 3
Sct
Venus
Aqr
Mars
Cap
Saturn
Neptune
Uranus
Sgr
Sco
CrB
Boo
Ser
Hebe
Pluto
Vi
Iris
Lib
PsA
Scl
Mic
Morning Sky
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11

Comet Austin is at its brightest in April

Hebe is at opposition on April 22

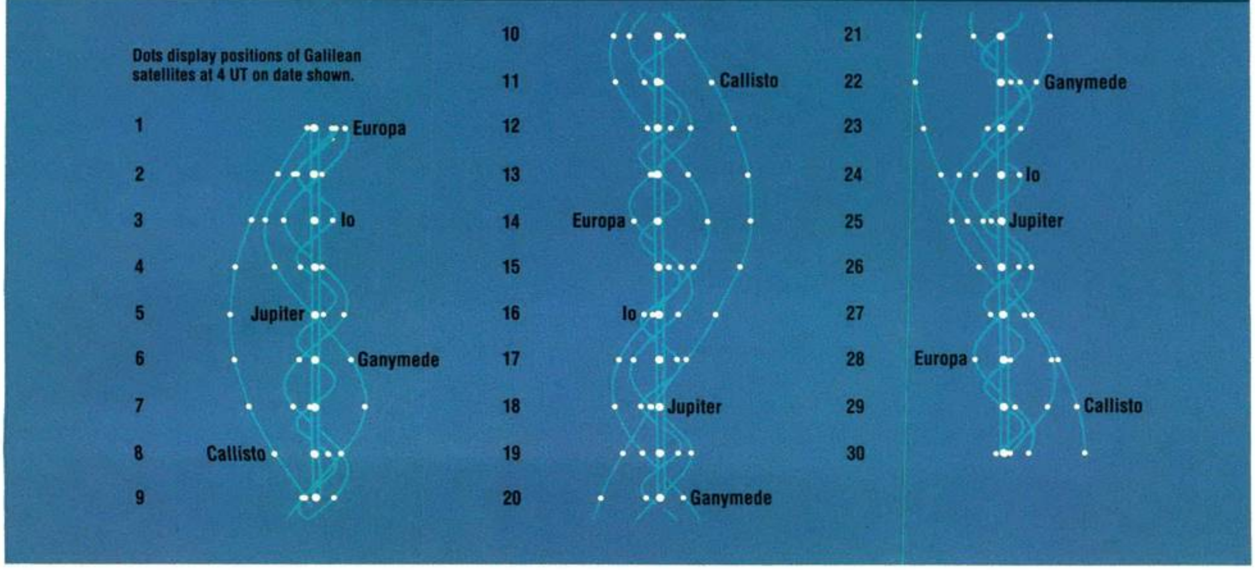
The Moon passes 1.8° south of Saturn on April 17/18



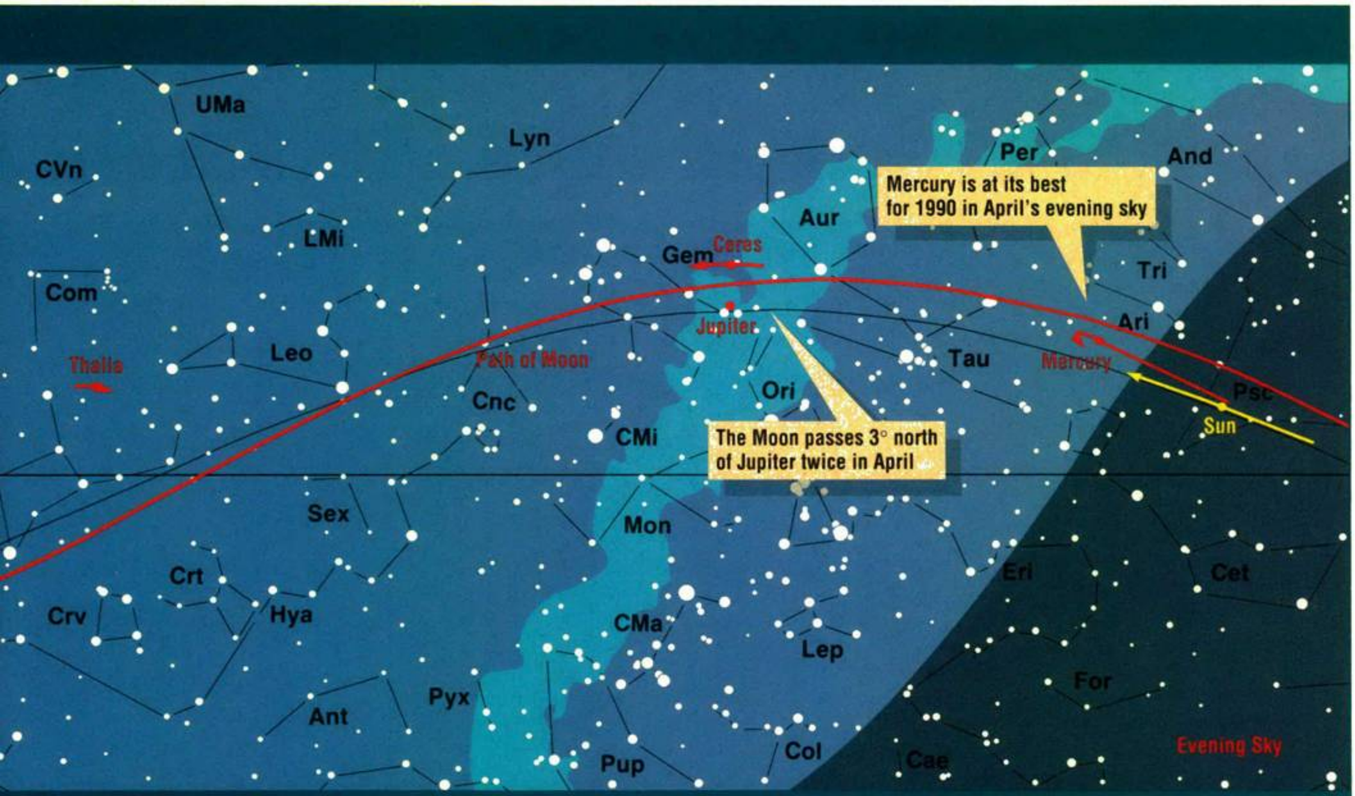


Planet	MERCURY	MERCURY	VENUS	VENUS	MARS
Date	April 1	April 15	April 1	April 30	April 15
Magnitude	–1.2	+0.4	–4.4	–4.2	+0.9
Angular Size	5.7″	8.0″	24.0″	18.1″	5.7″
Illumination	84%	35%	50%	64%	90%
Distance (AU) from Earth	1.185	0.839	0.695	0.921	1.643
Distance (AU) from Sun	0.308	0.352	0.724	0.728	1.421
Right Ascension (2000.0)	1h28.2m	2h43.5m	21h46.1m	23h45.2m	21h53.8m
Declination (2000.0)	10°00′	18°49′	–12°04′	–2°49′	–14°14′

Jupiter's Moons

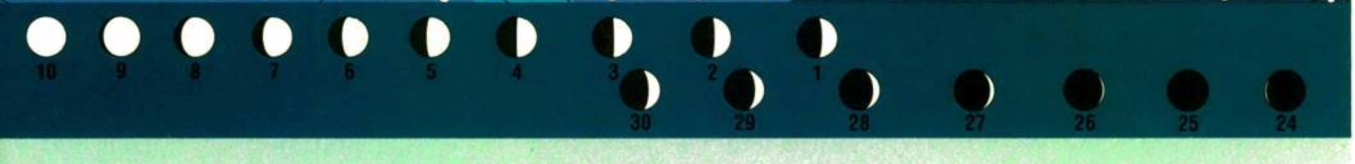


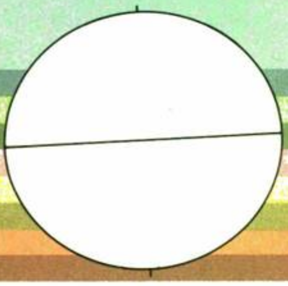
Dots display positions of Galilean satellites at 4 UT on date shown.

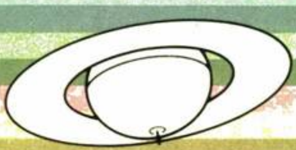

UMa
CVn
Lyn
LMi
Com
Leo
Thalia
Per
And
Aur
Gem
Ceres
Jupiter
Path of Moon
Cnc
Ori
Tau
Tri
Ari
Mercury
Psc
Sun
CMi
Sex
Mon
Crt
Crv
Hya
CMa
Lep
Eri
Cet
Pyx
Ant
Pup
Col
Cae
For
Evening Sky

Mercury is at its best for 1990 in April's evening sky

The Moon passes 3° north of Jupiter twice in April

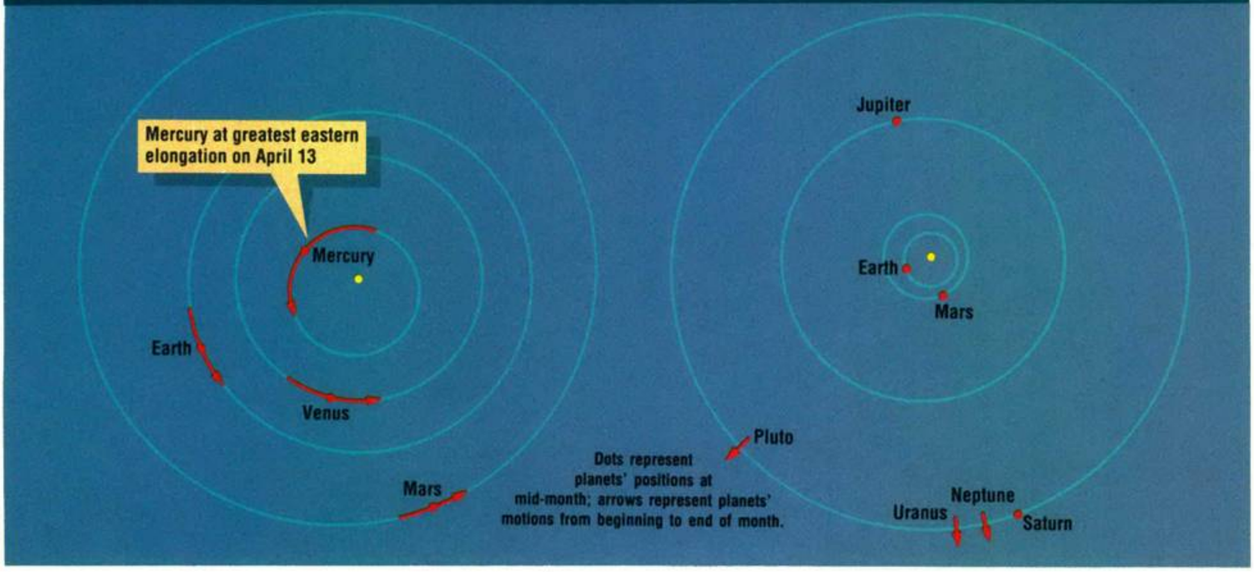

10
9
8
7
6
5
4
3
2
1
30
29
28
27
26
25
24





JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
April 15	April 15	April 15	April 15	April 15
−2.1	+0.6	+5.7	+7.9	+13.7
36.1"	16.6"	3.7"	2.2"	0.1"
99%	100%	100%	100%	100%
5.450	9.973	19.112	30.014	28.762
5.188	10.019	19.399	30.208	29.658
6h20.1m	19h48.2m	18h42.4m	19h03.4m	15h16.5m
23°28'	−20°55'	−23°23'	−21°46'	−1°35'

The Planets in Their Orbits


Mercury
Earth
Venus
Mars
Jupiter
Earth
Mars
Pluto
Uranus
Neptune
Saturn

Mercury at greatest eastern elongation on April 13

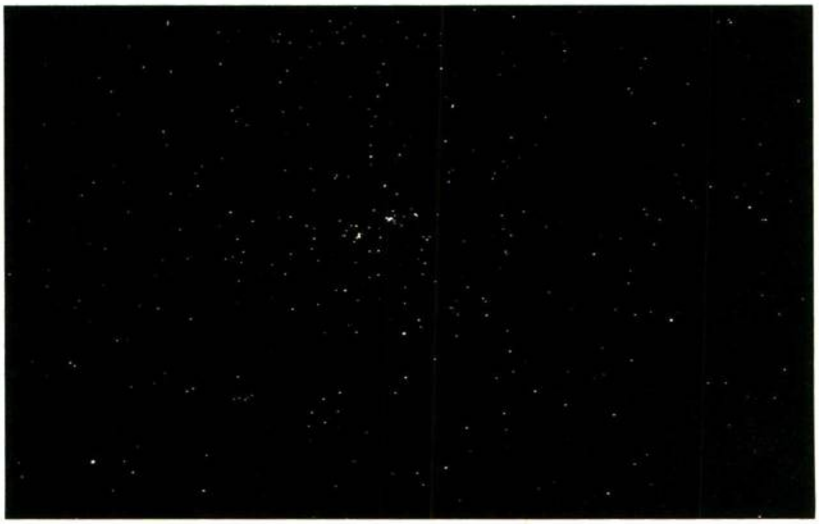
Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.

ASTRONOMY Tests a Dobsonian Equatorial Platform

This custom-made, motorized ground board gives your big Dob an hour of smooth tracking.

by Jeff Kanipe

THE SATURN OCCULTATION of 28 Sagittarii was recorded by Tom Osypowski with a 16-inch Dobsonian on his equatorial platform.



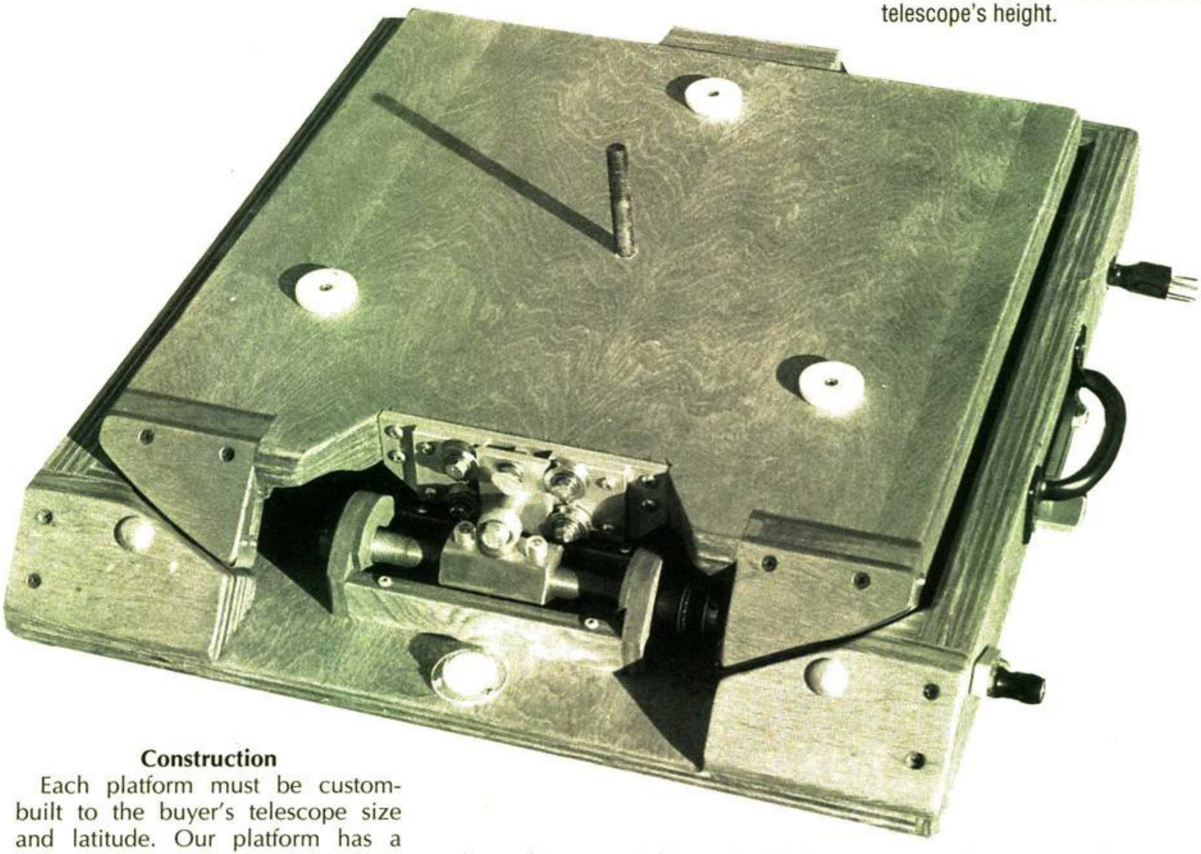
PIGGYBACK ASTROPHOTOGRAPHY with the platform yielded this unguided 2-minute exposure of the Double-Cluster region on Ektachrome 400 film.

One of the greatest strengths of a Dobsonian telescope — its solid altazimuth mount — is also its greatest weakness. Since no axis in an altazimuth system aligns with the celestial pole, the mount cannot be easily motor driven. You have to continuously nudge the tube to track the object in the field of view.

Almost as soon as the Dobsonian became popular in the mid-1970s, attempts were made to design a mount that could track. A real advance in this direction was made in 1977 with the introduction of a motorized ground board called a Poncet platform, named for its designer, French amateur astronomer Adrien Poncet.

Then in 1984, in an article written for *Telescope Making* magazine (*TM #24*), telescope makers and amateur astronomers read about Tom Osypowski's equatorial platform, itself a synthesis of two previous designs featured in *Telescope Making*. Like a Poncet, Osypowski's platform pivots around a bolt located on the southern end that is inclined at an angle equal to the observer's latitude. His design, however, does not rely on an inclined plane but rather two curved surfaces, or "feet," that ride on two roller bearings on the lower platform. This approach produces a lower center of gravity and, therefore, greater stability than the Poncet provides.

Four years after the article appeared in *Telescope Making*, Osypowski was selling custom-made versions of his platform. We wanted to see how stable the platform is and assess how well it tracks for both visual and photographic use. Last August we asked Osypowski to loan us a single-axis platform for a 13.1-inch f/4.5 Dobsonian. He had it built and delivered to our office by the end of November.



A LOW CENTER OF GRAVITY translates into a stable platform that adds only a few inches to the telescope's height.

Construction

Each platform must be custom-built to the buyer's telescope size and latitude. Our platform has a base 21 3/4" x 23" and weighs about 25 pounds. The wooden components are constructed from birch plywood, which is sanded and stained with two coats of sealer. To assure that all joints stay together, glue and screw construction is used throughout.

One limitation that immediately comes to mind is the latitude-specific construction: What if you leave your observing location for a different latitude? Is the platform still usable? The platform can be used in other latitudes by simply shimming the north or south side the appropriate number of degrees. A platform built for 43° latitude can be used for 40° latitude by shimming the south end 3°. At 46° latitude the north end would be shimmed 3°.

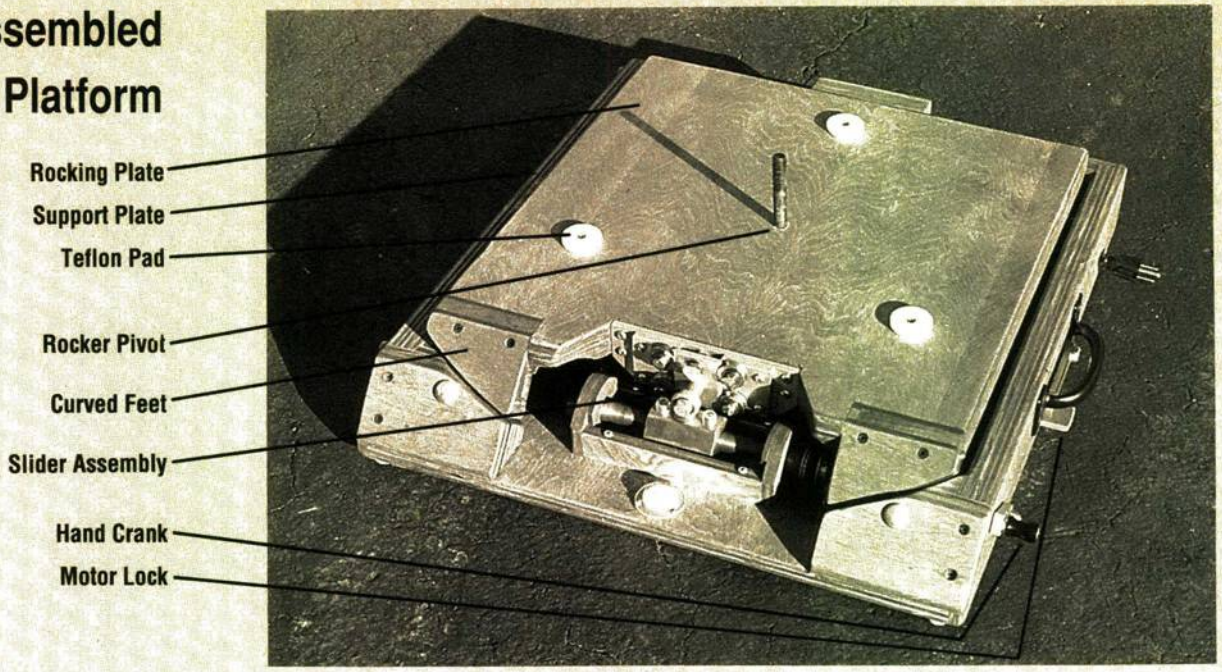
The greater the latitude difference, of course, the more the platform must be tilted, and this eventually imposes a limit. For example, our latitude is 43°. If we took our platform to the Texas Star Party in Fort Davis, Texas, (about latitude 31°), we'd have to raise the south side 12°, or about 5 inches — not the most stable situation for any size Dobsonian. This is a factor to consider before making a purchase. The traveling observer might contact Osypowski for an opinion on what the platform's limit of stability is for a specific telescope.

Another important limitation is that the single-axis model is designed primarily for visual use, piggyback astrophotography, and lunar and planetary photography. This type of platform does not have a declination adjustment. Observers interested in guided, long-exposure photographs through the telescope should consider Osypowski's dual-axis model, which is capable of fine adjustments in declination.

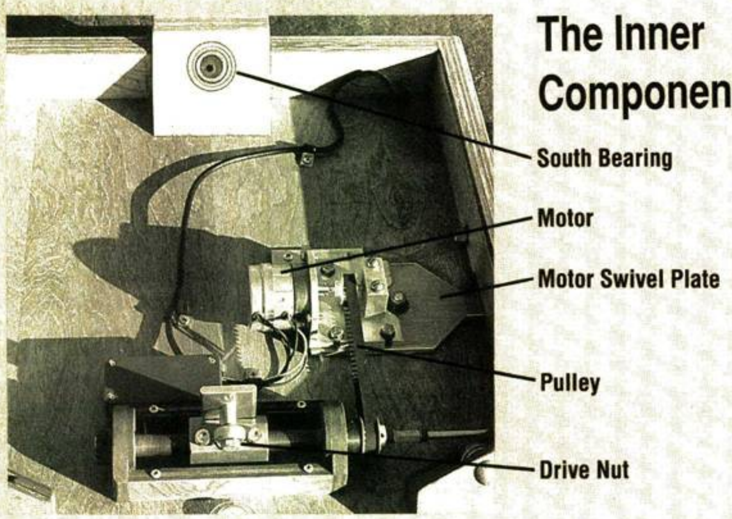
The platform has two sections, an upper rocking plate and a bottom support plate. The rocking plate replaces the scope's ground board in that the telescope's rocker box is secured to the rocking plate with a bolt (like that of the ground board) and the rocker swivels over three Teflon pads. Two curved "feet" are attached to the underside of the top plate on the north end and are inclined to the latitude angle.

The curved feet, attached to the underside of the rocking plate, allow the platform to arc through an hour's worth of right ascension by sliding

THE EQUATORIAL PLATFORM replaces the scope's ground board. (Patio bricks provide a level surface for the platform.)



The Assembled Platform



The Inner Components

DRIFTING STAR IMAGES, recorded with the platform's polar axis purposely misaligned, show a tolerable periodic error in the drive rod of about 24 arcseconds.

over two roller bearings located in the corners of the north side of the bottom support plate. The rocking plate pivots around the polar-axis bearing, which is positioned in the middle of the south side of the support plate.

Operating the Platform

All mechanical and electronic components are located on the support plate, under the rocking plate. When the platform is operating a synchronous motor actuates a belt that turns a drive rod through a brass drive nut. A ball joint mounted on top of the drive nut and threaded into the rocking plate via a "slider assembly" helps the rocking plate swivel smoothly as it is being driven.

Set up is simple. First, set the platform on a hard surface with the bubble level facing north. If necessary shim the corners until the platform is level and stable. Rough polar alignment is achieved by lining up either the east or west side of the platform with Polaris. For somewhat more accurate alignment, mount the telescope on the platform, square off the telescope's rocker box with the sides of the rocking plate, and sight on Polaris (or the region of celestial north) along the sides of the box. For astrophotography, the star-drift method must be used.

Once the telescope is mounted and the platform is aligned with Polaris, lift the motor lock on the west side of the platform and swivel the motor plate forward to disengage the drive belt from the pulleys. The rocking plate can then be positioned for an hour's tracking by turning the hand crank clockwise until the drive nut is all the way over to the right. (This tilts the rocking plate toward the east.) The motor is then relocked and the drive belt checked to make sure that it is seated on the pulleys.

There is no on-off switch. The platform simply begins tracking once plugged into a 110-volt source. The motor, sandwiched between the upper and lower plates, makes a subtle grinding sound. You can tell the platform is working normally by checking to see if the hand crank is turning freely. As the hour progresses the drive nut makes its way along the drive rod from right to left. At the end of its tracking run it trips a switch that automatically shuts off the motor. You then disengage the motor lock, shift the motor plate forward, rewind the drive nut, shift the motor plate back, and begin tracking for another hour.

Performance

We evaluated the platform's performance in terms of visual use, photographic use, and stability. The visual tests were made using three eyepieces: a 32mm Erfle (45x and a 1.4° true field), a TeleVue 21mm Plossl (68x and a 0.7° true field), and a 10mm Ultrascopic™ (144x and a 0.4° true field). Depending on the focal length of the eyepiece and how "rough" you polar align, tracking can be quite good. For visual purposes, we sighted Polaris along the edge of the platform as the manual suggests and averaged the results over a period of four nights.

A bright star remained centered in the 32mm Erfle eyepiece for about three and a half minutes before drift became noticeable. In the 10mm, drift was detected in about thirty seconds, but it took nearly four minutes before the star edged against the field stop. These results yield an average drift of about 2.5 to 3 arcminutes per minute.

For visual use, the platform works well. But for astrophotography success depends on accurate polar alignment. With rough polar alignment, tracking was good enough for recording the Moon at prime focus with 400-speed film. It was also suitable for a piggyback setup using fast film and a 50mm lens. Longer-focus lenses, however, required more precise polar alignment.

I polar aligned via the star-drift method and made several 3- and 4-minute *unguided* exposures of the Double Cluster, the Pleiades, and the Orion Nebula using Ektachrome 400 film. Although some of the exposures were trailed slightly, a single-axis drive corrector and careful guiding through the telescope using a high-power eyepiece would no doubt produce even better results.

The tracking exhibited no discernible jerkiness and an acceptably small periodic drive error. The user's guide suggests that the backlash adjustment set screws, located at each end of the drive nut, should be tightened just enough to minimize backlash of the drive nut without slowing down the rod. I never had to make these adjustments.

Our only complaints with the platform are minor ones that could easily be fixed by the manufacturer. First, the platform's handle is difficult to grasp because of its location near the motor plate and lock. The motor plate protrudes in such a way that your fingers can't wrap securely around the handle without pinching. We also had trouble with the crank not turning freely on the side of the platform. After resetting the mechanism one time, the threaded handle screwed down so tightly against the side of the platform that the motor locked up. This was fixed by simply placing a washer between the crank and the housing. Finally, after plugging and unplugging the platform in the dark a few dozen times, I think an on-off switch would be a convenience.

Observers who have longed for a painless method of driving their Dobsonians equatorially will welcome Osypowski's platforms. However, be prepared to pay serious bucks for his design. (See above.) Platforms are available for telescopes as large as 26". Osypowski will also provide telescope makers with the mechanical parts and drive assemblies needed to build their own platforms at a reduced price.

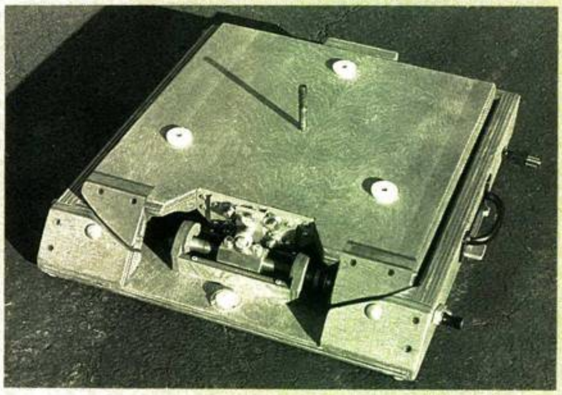
The equatorial platform we tested provided an hour's worth of smooth tracking without sacrificing Dobsonian portability or stability. The platforms are well made, easy to use, and, with a little shimming, can be used at other latitudes. Although the cost may seem high, the opportunities and advantages afforded by a motorized equatorial platform are worth the price. ☐

Tom Osypowski's Equatorial Platform

A motorized equatorial platform for Dobsonian telescopes, custom-made for the observer's telescope size and latitude. The platform, which provides up to an hour of tracking time, consists of two sections: the top rocking plate, which supports the telescope and has two curved "feet" inclined at the observer's latitude angle on the north end; and the support plate, containing the drive system, north roller bearings, and south pivot bearing. Two types of platforms are available. Single-axis platforms are suitable for visual use, lunar and planetary photography, and piggyback astrophotography. Dual-axis platforms, when used with a dual-axis drive corrector, allow for declination adjustments and are recommended for prime-focus deep-sky photography.

Manufacturer: Tom Osypowski, 11065 Peaceful Valley Road, Nevada City, California 95959; (916) 265-3183 (evenings).

List Price: For 12" to 14" Dobsonians, $875 single axis, $1,125 dual axis. For 16" to 18" Dobsonians, $1,175 single axis, $1,750 dual axis. Larger sizes available. Mechanical parts and drive assemblies can also be supplied. Price list available.



Pros: Smooth tracking; stable, portable design; stout drive system; quick and easy set up.

Cons: No on-off switch; carrying handle too close to motor swivel-plate lock; limited latitude range; high price.

Summary: A sturdy customized motorized equatorial platform for owners of large Dobsonian telescopes. A heavy-duty threaded drive system provides an hour of smooth tracking for visual use or for those who want to photograph the planets, Moon, Sun, or engage in piggyback astrophotography. The platform's low center of gravity adds about three inches of height to the telescope, allowing for quick set up and portability.

ORION
TELESCOPE CENTER

Toll Free 800-447-1001
In Calif. 800-443-1001

MasterCard VISA

Your #1 Source for Major Brands

Orion carries a large selection of major brand astronomical equipment at discount prices.

CELESTRON · Edmund Scientific · Meade · TeleVue

Celestron

Orion is the place to buy Celestron astronomical equipment, from binoculars to Schmidt-Cassegrains. We stock the latest models and the best selection of Celestron optical equipment, all at competitive prices.

Meade

From Meade's high quality 80mm refractors to their Schmidt-Cassegrains, Orion has a large selection of Meade's fine optical instruments and accessories, at competitive prices.

100% Money-Back Guarantee

We want you to be satisfied! If you are not completely satisfied with your purchase for any reason, just return it in new condition within 30 days after delivery for a full refund.

ORION TELESCOPE CENTER
MONEY-BACK GUARANTEE

Free Catalog

Filled with the best in name brand telescopes, binoculars, and accessories, plus page after page of helpful reference information to make your hobby more enjoyable.

Orion® TeleVista 60mm Altazimuth Refractor

Finally, an affordable small telescope equally at home viewing the rings of Saturn or boats across the bay. One of the most popular sellers in Orion retail stores, it will provide years of enjoyment viewing celestial and earthly delights.

This fine telescope includes a quality coated 2-element achromatic objective lens for sharp, clear images. The sturdy all-metal optical tube and mount is attractive and durable. Includes a sturdy, adjustable wooden tripod, smooth rack-and-pinion focuser and right-angle coated diagonal prism. Includes two quality Kellner eyepieces with standard .965" barrels: 25mm (28x) and 9mm (78x).

An outstanding choice for observers of all ages.

#9091 Was $199 **Now $169** (8.85)

Orion® Enhanced™ Giant Binoculars

20% more light transmission than ordinary "fully coated" binoculars. Fully Multi-Coated optics and superior BAK-4 prisms provide fantastic contrast and greatly improved edge sharpness.

11x80 MC- Brightest, widest-field available. Ideal for deep-space observation under dark skies. Hand-holdable.

#9502 Was $369 **$349** (5.55)

16x80 MC- 45% higher power, excellent for astronomy and daytime observation. Tripod recommended.

#9496 **$379** (5.95)

20x80 MC- Highest power model perfect for smaller deep-space objects and long range daytime views. Tripod required.

#9498 **$389** (5.95)

Orion® 10x70 Enhanced Giant Binoculars

Big binocular performance in a lightweight package you can hand-hold for hours. Ideal for sweeping the dust-lanes of the Milky Way. Fully Multi-Coated, BAK-4 Prisms. Fantastic!

#9501 **$279** (5.15)

Orion® Little Giant™ 9x63 Fully Multi-Coated Roof Prism Binoculars

Popular mid-sized binocular, Fully Multi-Coated and remarkably light weight. Excellent contrast and sharpness at center of field, although edge sharpness is not as good as our porro-prism binoculars. 6° field of view. Weight, 2.8 lbs.

#9500 **$199** (4.19)

Orion® Sky Explorer™ Mini Deep Sky 8x56 Binoculars

56mm objective lenses gather over 2.5x the light of ordinary 7x35 binoculars. Perfect for viewing faint celestial objects, daytime viewing. Best Multi-Coated BAK-4 optics. 6° field of view.

#9504 Was $149 **Now $139** (3.79)

Superior Performance 7x50 Adlerblick Binoculars

Incredible wide-field eyepiece design, fully multi-coated BAK-4 prisms and best special glass objective lenses establishes the 7x50 Adlerblick as the arch-rival of European brand binoculars selling for 3-4 times the price. Orion buys direct, so you save money. Includes deluxe hard case, lens caps, and straps.

#9612 **$269** (3.99)

Orion® Super Compact 8x21 Folding Binoculars

Price breakthrough on these great, pocket-sized all purpose binoculars. Roof-prism optical system with center-focus design puts powerful 8x optics in a 10 oz. package. Ideal for hiking, theater, sporting events, glove compartment.

#9509 Was $79 **Now $69** (2.29)

Orion® Sky Explorer 60mm Equatorial Refractor

Designed for home astronomy, the new Sky Explorer is ideal for lunar and planetary study, while also providing good views of nebulas, star clusters and galaxies. By day, it's a powerful terrestrial telescope, great for bird watching, nature study, and scanning distant vistas.

The Sky Explorer features a 900mm focal length; $MgFl_2$ coated objective lens; 6x30 crosshair achromatic finderscope; rack and pinion focuser; fully-coated, right-angle star diagonal prism; two quality fully-coated Kellner eyepieces, 25mm (36x) and 9mm (100x); all metal mounting system; worm gear slow-motion control knobs, celestial coordinate setting circles; dual flexible control cables; adjustable counterweight; hardwood tripod; and lighted accessory tray.

#9092 Was $339 **Now $329** (10.90)

Orion® Explorer Series 1.25" Eyepieces

Remarkably affordable, Multi-Coated parfocal eyepieces with great performance. Each carefully selected series has been chosen to provide a sensible progression of magnifications. Threaded for filters. Internally blackened to prevent stray light reflections.

1.25" Kellner Eyepieces-
6mm #8536, 9mm #8538, 12mm #8540, 18mm #8508
25mm #8510, 40mm #8512

$33.95 ea. (1.89)

1.25" Orthoscopic Eyepieces- 5mm #8500, 7mm #8502
9mm #8504, 12.5mm #8506, 18mm #8524, 25mm #8526

$49.95 ea. (1.89)

Orion® Explorer Series .965" Eyepieces

Get the most from your small telescope with these fine fully-coated eyepieces. Standard .965" barrels fit all Japanese standard small telescopes.

.965" Orthoscopic Eyepieces-
5mm #8580, 7mm #8581
9mm #8582, 12.5mm #8583

Was $42.95
Now $36.95 ea. (1.89)

965" Kellner Eyepieces- 18mm #8584, 25mm #8585
965" Achromatic Huygenian Eyepieces- 40mm #8586

Was $32.95
Now $24.95 ea. (1.89)

Orion® 2" Multi-Coated Eyepieces

Excellent quality wide-field eyepieces

32mm Erfle 2" Eyepiece

#8492 **$99** (2.59)

50mm Plössl 2" Eyepiece- Offers the brightest, widest field. Preferred for faint celestial phenomena.

#8490 **$79** (2.59)

Orion® 2" Star Diagonal

Get the widest possible field of view from your Schmidt-Cassegrain Telescope. This star diagonal features a special aluminized and overcoated first-surface 1/4-wave flat mirror.

#8767 **$89.95** (2.59)

Quality, Affordable Orion® Barlow Lenses

Achromatic, fully coated 2-element lens system with finest machined aluminum construction. Ideal for reflector and refractor telescopes.

2x 1.25" Barlow Lens #8744 **$39.95** (1.89)

2x .965" Barlow Lens #8742 **$27.95** (1.89)

World's Finest Illuminated Reticle Eyepiece

6mm Orthoscopic design for required high-power guiding, plus unique X-Y, adjustable reticle positioning for easy guide-star alignment. Wireless LED illuminator has adjustable brightness.

#8487 Was $149 **Now $129** (2.69)

Orion® 9mm Orthoscopic Illuminated Reticle Eyepiece

9mm Orthoscopic eyepiece with wireless adjustable brightness illuminator. Bull's-eye within three concentric circles helps measure limits of acceptable guiding error.

#8488 **$119** (2.69)

Orion® 12mm Kellner Illuminated Reticle Eyepiece

12mm Kellner eyepiece with cable plugs into LX/3 and LX/5 drive bases, and most drive correctors with illuminated reticle output for polar alignment and guiding.

#8482 Was $79 **Now $69.95** (2.19)

Orion® MegaVista™ 1.25" Wide Angle Eyepieces

Incredible fully multi-coated high-transmission 7-element eyepieces with integral rubber eyeguard and long eye-relief.

10.5mm- An incredible 67° field for outstanding planetary or deep space performance.

#8552 **$129** (2.29)

16.8mm-Outstanding high-contrast eyepiece with stunning 70° field ideal for deep space.

#8554 **$139** (2.29)

Orion® UltraZoom™ 7-21mm 1.25" Eyepiece

The finest zoom you can buy for your 1.25" telescope. An excellent choice for astronomy or terrestrial observing. 65°-35° field.

#8556 Was $149 **$129** (2.29)

Orion® VariPower™ 2-3x Multi-Coated Barlow Lens

Our new variable barlow offers significant improvement over other models we've seen. The magnification is adjusted by sliding the internal lens cell along a calibrated scale (you don't have to poke a finger or pencil inside to do this). Fully Multi-Coated optics provide excellent sharpness, contrast and brightness. 1.25" diameter.

#8748 **$69.95** (2.19)

Orion® Ultrascopic™ 3-element Fully Multi-Coated Barlow Lens

Fully Multi-Coated 3-Element Barlow lens provides superior imaging with precise color correction at three wavelengths. For maximum light transmission and highest contrast, we have used the finest quality multi-coating on each air to glass surface. 1.25" Diameter

#8750 Was $69 **Now $59.95** (2.19)

Orion® Deluxe Fully-Baffled Multi-Coated Barlow Lens

Fully internally opaqued and baffled to block stray light for noticeably higher contrast. Large 27mm multi-coated 2-element lens provides 2x magnification with any 1.25" eyepiece.

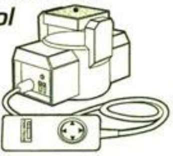
#8746 **$49.95** (2.09)

America's #1 Source for Telescopes and Binoculars

2450 17th Ave., P.O. Box 1158-A, Santa Cruz, CA 95061

ORION
TELESCOPE CENTER

Orion® Motorized Slow Motion Control



Get the utmost in smooth tracking with this new motorized pan head. Attaches between any tripod and binocular or spotting scope (maximum wt. 6 lbs.) with standard 1/4-20 threads. Two motors provide independent adjustment of vertical and horizontal motion. Auto Pan Mode allows continuous horizontal panning motion in a 30°, 60° or 90° arc. Hand control features easy pushbutton directional control and variable speed adjustment. The maximum horizontal angle is ±90°, the maximum vertical angle is ±15°. Includes jack for 6v DC power supply. Uses 4 AA batteries (not included).

#5016 **$189** (3.89)

Orion® Dual Balance System

Finally, a simple balance system that really works! Unlike ordinary counterweights, our system allows instant adjustment in both directions. Easily balances your scope to offset both piggyback loads or rear-cell cameras, 2" diagonals, and other accessories. Rigid, precision machined dovetail bar mounts to telescope in existing accessory holes.

For Meade 8" 2080 #5150 **$74.95** (3.46)

For Celestron 8" C-8 #5149 **$79.95** (3.46)

For Meade 10" 2120 #5152 **$84.95** (3.46)

Orion® Premium Off-Axis Guider

Use with any 1.25" Illuminated Reticle Eyepiece. For Meade and Celestron Schmidt-Cassegrains.

#5144 **$59.95** (1.89)

Orion® Universal Combined Camera Adapters

Combination Eyepiece Projection Tube and Prime Focus Adapter for refractors and reflectors with 1.25" eyepiece holders. Use with T-Ring (sold separately) to match your 35mm camera.

Standard Universal Camera Adapters

For .965" Eyepiece Holders #5268 **$29.95** (1.89)

For 1.25" Eyepiece Holders #5264 **$34.95** (1.89)

Variable Power Camera Adapter
Unique sliding barrel design allows variable projection distances during eyepiece projection photography, eliminating the need to change eyepieces when magnification changes are required.

#5262 Was $49.95 **Now $44.95** (1.89)

Orion® T-Adapter

For prime focus photography. Use with T-ring to match your 35mm camera. For Meade, Celestron 8", 10" SC.

#5116 **$27.95** (1.89)

Orion® Tele-Extenders

For high powered photography with your Meade, Celestron 8", 10" Schmidt-Cassegrain

Standard Tele-Extender
Use this Tele-Extender in conjunction with an eyepiece. Attaches to visual back of Meade or Celestron Schmidt-Cassegrain telescopes, and to 35mm camera with T-ring, sold separately.

#5125 **$27.95** (1.89)

Variable Tele-Extender
Uses an adjustable extension tube, allowing magnification to be changed without switching eyepieces. Thumbscrews lock extension tube securely in place. Attaches to 35mm camera with T-ring, sold separately.

#5127 **$39.95** (1.89)

Orion® Tele Compressor

Get four times the brightness and 1/2 the exposure time. Doubles your field of view for astrophotography. For Meade, Celestron 8", 10" SC.

#5141 **$34.95** (1.89)

Orion® SkyGlow™ Enhanced Light Pollution Filters

Enhance your viewing of faint deep sky objects with the best broadband light pollution filter you can buy. Our SkyGlow absorbs frequencies emitted by city lights, allowing transmission of the rest of the visible spectrum, yielding dramatic results.

SkyGlow Broadband Filters-
For use in slight to moderately light polluted areas.

1.25" Broadband Filter- fits 1.25" eyepieces #5660 **$66.50** (1.89)

Schmidt-Cassegrain Broadband Filter- fits rear cell of Meade & Celestron SC scopes #5658 **$99** (2.19)

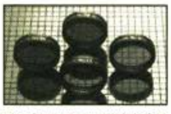
52mm Broadband Filter- fits all camera T-rings #5668 **$66.50** (1.89)

SkyGlow UltraBlock Filters-
For use in severely light polluted areas.

1.25" UltraBlock Filter- fits 1.25" eyepieces #5654 **$77.50** (1.89)

Schmidt-Cassegrain UltraBlock Filter- fits rear cell of Meade & Celestron SC scopes #5656 **$119** (2.19)

Orion® Color Filters for Eyepieces



Solar system observations are dramatically improved by Orion colored filters. For visual use, thread one into the barrel of any standard eyepiece. For planetary and lunar photography, Schmidt-Cassegrain owners can attach the filter to the eyepiece inside the tele-extender. Can also be threaded directly into a universal camera adapter.

Basic Set of 4 Filters .965"
Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.

#5510 Was $36.95 **Now $29.95** (1.89)

Basic Set of 4 Filters 1.25"
Includes #80A Blue, #58 Green, #25 Red, #15 Yellow.

#5514 Was $44.95 **Now $39.95** (2.19)

Expansion Set of 4 Filters 1.25"
Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.

#5516 Was $44.95 **Now $39.95** (2.19)

Deluxe Set of 8 Filters 1.25"
Includes all the filters in our basic and expansion filter sets.

#5517 Was $79 **Now $74.95** (2.79)

Individual 1.25" Filters-
#80A Blue (#11040), #58 Green (#5540), #25 Red (#5536), #15 Yellow (#5532), #21 Orange (#5534), #47 Violet (#5538), #11 Light Yellow-Green (#5530), #82A Very Pale Blue (#5544)

$11.95 ea. (.99)

Orion® Moon Filters

Cuts 87% of the light from the Moon. Reduces glare by uniformly reducing light transmitted over the entire spectrum.

For .965" Eyepieces #5664 **$14.95** (1.89)

For 1.25" Eyepieces #5662 **$14.95** (1.89)

Variable Polarizing Filter Set

Adjustably reduces the light transmission of visual images, so you can see more detail. Also ideal for cutting glare from water, window glass during terrestrial observation.

For .965" Eyepieces #5558 **$19.95** (1.89)

For 1.25" Eyepieces #5560 **$24.95** (1.89)

Porta Pac Rechargeable Batteries

5.0 Amp Hour Porta Pac
Perfect for Meade LX6, LX5, and LX3; and Celestron Powerstar 8, and SPC-8 (with adapter). Also suitable for all drive correctors and motor drives. Battery is encased in high-impact polystyrene. Built-in handle. Wt. 5 lbs.

#2352 **$69 ea.** (4.56)

12 Amp Hour Porta Pac
Ideal for operating your telescope plus higher power-consuming accessories such as an Orion Dew Zapper. Battery is encased in high-impact polystyrene. Carrying case of Cordura nylon with shoulder strap and handle. Wt. 10 lbs.

#2354 **$99 ea.** (6.23)

Astronomer's Choice

Orion® Ultrascopic™ Eyepieces

Unlike other premium eyepieces, Orion Ultrascopics offer complete multi-layer coatings on ALL surfaces, for superior light transmission and contrast. Modern 5- and 7-element designs for pinpoint star images and breathtaking detail. Wide 52° field of view. Compare with other brands selling for much more!

Wide Field 5-element

35mm Ultrascopic #8560 **$99** (2.29)

30mm Ultrascopic #8562 **$89** (2.19)

25mm Ultrascopic #8564 **$79** (2.19)

Medium-High Power 5-element
20mm Ultrascopic #8566,
15mm Ultrascopic #8568
10mm Ultrascopic #8570,
7.5mm Ultrascopic #8572

$74.95 ea. (2.19)

High Power 7-element
5.0mm Ultrascopic #8574,
3.8mm Ultrascopic #8576

$87.50 ea. (2.19)

Orion® Star Diagonals

1.25" Star Diagonal
Primarily for astronomical use, lets you view at a right angle. Multi-coated, for 1.25" eyepieces. Not compatible with most reflectors due to insufficient focusing range.

#8763 **$39.95** (1.89)

.965" Star Diagonal
Same as 1.25" Star Diagonal, but with standard coated optics. Works with .965" eyepieces and eyepiece holders.

#8761 **$24.95** (1.89)

Hybrid Star Diagonal
Adapts 1.25" eyepieces to .965" eyepiece holders of refractor and most compound reflectors (does not work with .965" Newtonian Reflectors).

#14008 **$29.95** (1.89)

Orion® 2x Rich Field Adapter

Get four times brighter image and twice the field of view. For Meade, Celestron 8", 10" Schmidt-Cassegrains.

#5128 **$89** (2.29)

Astrogoggles

Allows eyes to adjust to night-vision in the comfort of your home.

#5942 **$19.95** (1.89)

Orion® Deluxe Padded Field Tripod Tote Bag

Heavily padded Cordura bag with sturdy zipper holds tripod and wedge combinations for 8" and 10" Schmidt-Cassegrains. Large girth allows storage of wedge without changing polar alignment. Padded insert separates wedge from tripod during transportation. Internal pocket holds hardware.

#15096 **$79.95** (4.28)

Economy Tote Bag- Similar to above without padding.

#15095 **$34.95** (3.59)

Popular Observer's Chairs

Make observing more comfortable and enjoyable with one of these great chairs.

Standard Model-
Has adjustable-height center column and padded vinyl seat. Folds for easy storage.

#5935 **$39.95** (3.69)

Deluxe Model-
Is much heavier-duty, built for professional musicians. Extra thick padding, wide footprint. Adjustable, disassembles for storage.

#5934 **$88** (5.65)

Deluxe Metal-Clad Accessory Cases

Keep your accessories, camera, safe and clean. Diced foam inserts can be tailored to your needs. Sturdy handle, two latches with key.

Regular Case- 16"x12"x6-1/2" #5920 **$49.95** (5.09)

Large Case- 19-1/2"x12"x6-1/2" #5921 **$64.95** (5.92)

Orion® Dew Zapper

Orion's Dew Zapper is a sure-fire cure for dew problems on your 8" or 10" Celestron or Meade Schmidt-Cassegrain telescope. Dew Zapper gently replaces lost heat, bringing the corrector plate temperature slightly above air temperature.

8" Dew Zappers- fit all Meade and Celestron 8" Schmidt-Cassegrains

DC Model #3503 Reg. $39.95 **$34.95** (1.79)

AC Model #3504 Reg. $39.95 **$34.95** (1.79)

10" Dew Zappers- fit all Meade 10" Schmidt-Cassegrains

DC Model #3506 Reg. $44.95 **$39.95** (1.79)

AC Model #3508 Reg. $44.95 **$39.95** (1.79)

Dew Remover Gun

Moisture that interferes with viewing dissipates quickly with this 12V DC, 156 watt warm air gun. Has 4-1/2' cord.

#5601 **$17.95** (2.09)

Starlite Red LED Flashlight

The Starlite is the only adjustable-brightness night-vision red flashlight. Lifetime solid-state LED can't burn out. Extra efficient electronic circuit for long battery life. Uses one 9-volt battery (not included).

#5714 **$24.95** (1.89)

Astronomer's Flashlight

Indispensable and indestructible. Has special night-vision red filter and a diffusion lens for even illumination. An essential addition to your astronomy accessories. Requires 2 D-cell batteries (not included).

#5701 **$8.95** (1.89)

NiteWriter Pen

Incredible pen with built-in red light! With extra refill, batteries.

#5709 **$8.95** (1.89)

Large Deluxe Eyepiece Case

A larger version of our popular case. Available in universal 'diced foam' version you tailor yourself, or die-cut model perfect for 2" star diagonal and both 2" and 1.25" eyepieces and accessories. O.D. 9-1/2"x13"x5-5/16".

Large Deluxe Case with Pre-Cut Foam #5916 **$29.95** (2.69)

Large Deluxe Case with Diced Foam #5914 **$27.95** (2.69)

Deluxe Eyepiece Case

Organize and protect your valuable eyepieces and other accessories. This durable case with double hinges holds up to 10 eyepieces plus barlow. Die cut foam insert for snug secure fit. O.D. 8-1/2"x12-1/2"x3-1/8".

#5913 **$17.95** (2.09)

Serving Amateur Astronomers Since 1975

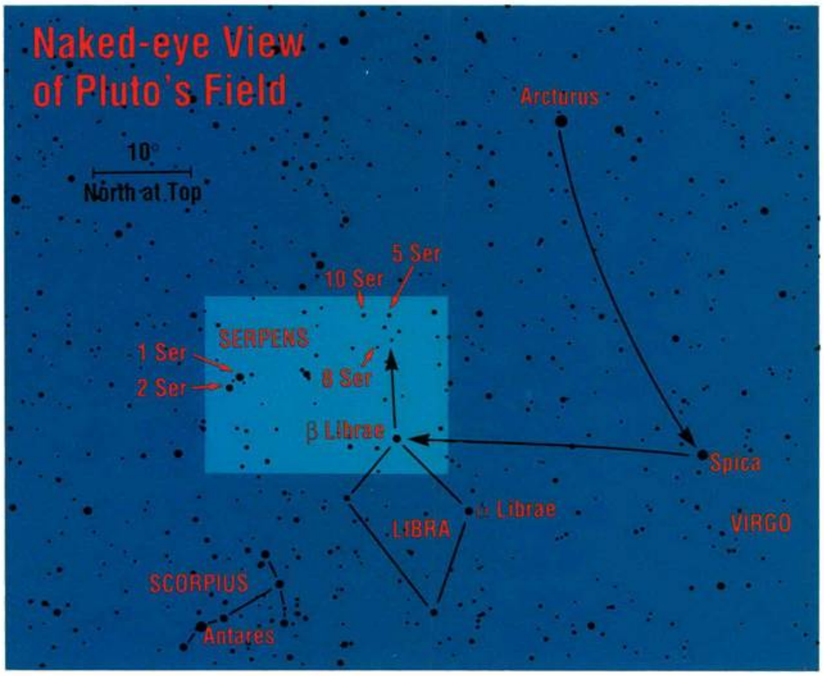
IT'S EASY TO ORDER!

- Call Toll Free and charge to your Visa or MasterCard, or send your personal check to order by mail.
- Shipping & handling charges for UPS Ground or U.S. Mail to lower 48 states only are listed in (parentheses) after each price.
- We ship to U.S. and Canada only.
- California residents add 6.25% sales tax (Santa Clara County 7.25%).

Hunting the Last Planet

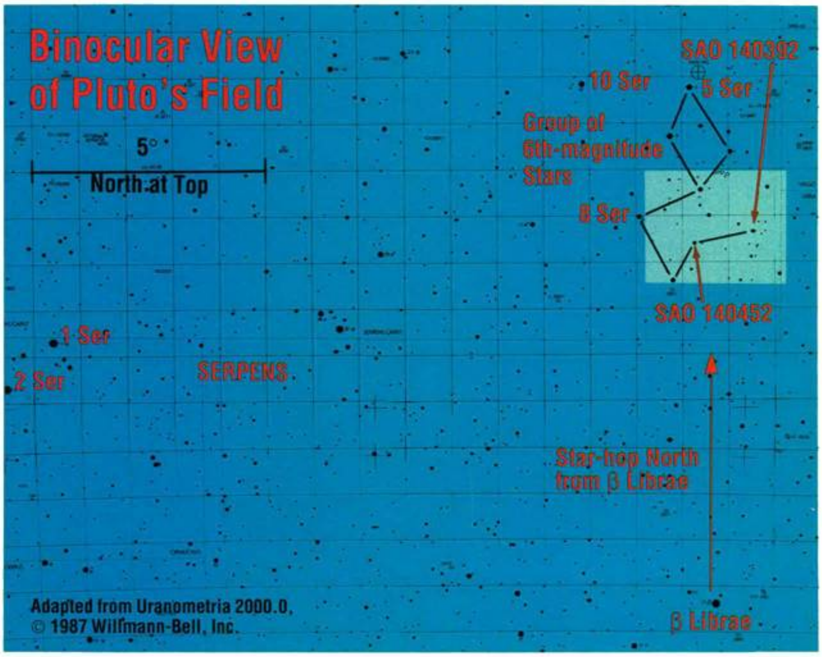
This spring Pluto will be closer to Earth than it's been for 248 years. Here's your complete guide to tracking down this elusive planet.

by Alan Dyer



Naked-eye View of Pluto's Field

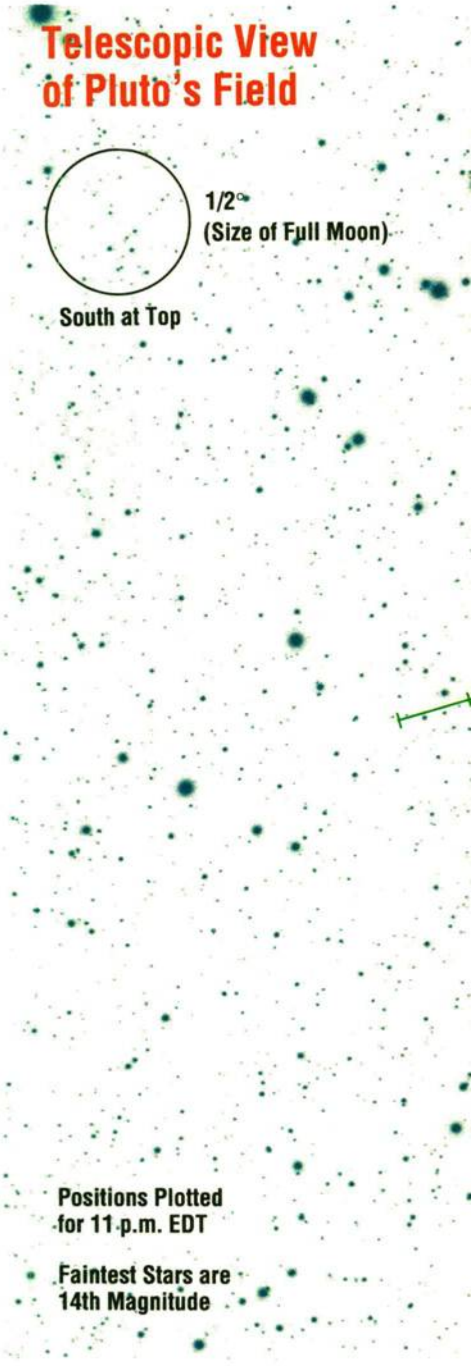
10°
North at Top
Arcturus
5 Ser
10 Ser
SERPENS
1 Ser
2 Ser
8 Ser
β Librae
Spica
α Librae
LIBRA
VIRGO
SCORPIUS
Antares



Binocular View of Pluto's Field

5°
North at Top
SAO 140392
10 Ser
5 Ser
Group of 6th-magnitude Stars
8 Ser
SAO 140452
1 Ser
2 Ser
SERPENS
Star-hop North from β Librae
β Librae

Adapted from Uranometria 2000.0, © 1987 Willmann-Bell, Inc.



Telescopic View of Pluto's Field

1/2°
(Size of Full Moon)
South at Top

Positions Plotted for 11 p.m. EDT

Faintest Stars are 14th Magnitude

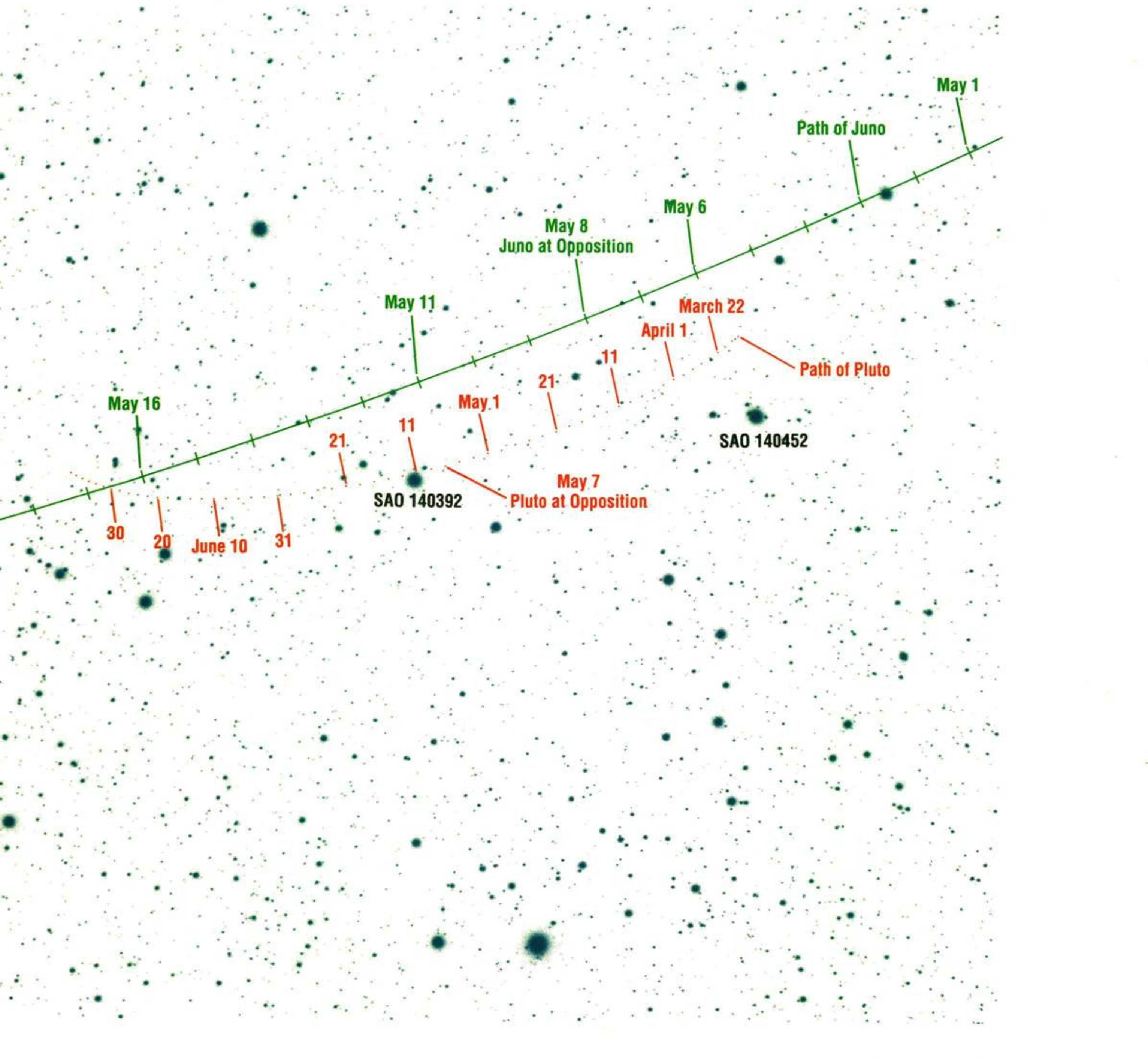
Have you seen all nine planets? Not many astronomers, either amateur or professional, can make that claim. Since it appears only as an extremely faint speck you might think Pluto is too difficult to find. True, it takes a special effort, but the satisfaction of tracking down this elusive outer planet is therefore all the greater. And this spring is the best time in the next 247 years to locate the ninth planet.

A Special Year for Pluto

This year is the sixtieth anniversary of Pluto's discovery by Clyde Tombaugh. Finding Pluto for yourself will drive home the immensity of the task Tombaugh faced back in 1930. Locating this planet is challenging enough when you know exactly where it is; imagine what it was like to find it when you had a whole sky to search. It was the proverbial needle well hidden in a celestial haystack.

However, there's another good reason for hunting Pluto in 1990. This spring Pluto is as bright as it can ever get. Although still faint with a magnitude of only 13.6, it's a little easier to see than in previous years. The reason for the favorable viewing is that Pluto reached its closest point to the Sun, or perihelion, on September 5, 1989. This event occurs only once every Plutonian year, which is equal to 248 Earth years. By May 1990, some eight months later, Earth will have traveled around its orbit so that our planet will be directly between Pluto and the Sun. This puts us as close as we can get to Pluto. This alignment is called opposition since at that time Pluto is directly opposite the Sun in our sky. The exact time of opposition this year is 5 UT on May 7 (1 a.m. EDT).

Dedicated plutocrats, to use one of Clyde Tombaugh's infamous puns, will recall that last year everyone was saying 1989 was the best



time to see Pluto. After all, the May 4, 1989, opposition of Pluto occurred when the planet was only four months from its rare perihelion point. Therefore Pluto should have been closer to us *last* year. What's going on?

At last year's opposition Pluto was indeed closer to the Sun than it is this spring. But this year opposition occurs three days later than it did in 1989. Therefore Earth is three days closer to its annual July 4 aphelion point, the point when our planet is farthest from the Sun. This means that while Pluto has receded over the last year, the fact that Earth is also farther from the Sun more than makes up the difference. However, the difference is very small: at opposition this year the separation between our two planets is a mere four Earth diameters less than it was at opposition in 1989.

Finding the Needle

Pluto hunting requires at least an 8-inch telescope. You'll also need a dark, moonless sky and a night with reasonably steady seeing. If your telescope is equipped with them you might be tempted to use setting circles or a computerized drive, but they pose a problem. While they might get you into the right area, you'll likely be totally disoriented once you're there and unable to match the stars in your eyepiece to the stars on the charts.

The best approach is to carefully hop through the stars, gradually narrowing your search area until you know you have the right star pattern exactly centered in a medium-power eyepiece. This allows you to pick out Pluto as the faint star that "doesn't belong."

The journey to Pluto will take you through fields of increasingly fainter stars. To accomplish this star hop take it one step at a time:

1) Follow the curve of the handle of the Big Dipper down to Arcturus, the brightest star in the spring sky.

2) Continue this curving arc down another 30° until you come to the brightest star in the constellation Virgo. This is Spica.

3) Now head east. At almost the same declination as Spica but 26° degrees east is Beta (β) Librae, also known by the tongue-twisting name Zubenelschamali.

4) From Beta (β) Librae, you have to blaze a trail due north, or straight up in declination, into faint-star territory. Go north about 10°, or roughly two finder scope fields. This puts you amid a small grouping of 6th- and 7th-magnitude stars just south of M5, a bright globular cluster. M5 should be visible in your finder scope.

5) Study this grouping carefully. Pick out 8 Serpentis, a 6.1 magnitude star that's near the south end of this group.

6) Use 8 Serpentis as the jumping-off point to take you to the final guide stars. These are two 7th-magnitude stars known only as SAO 140452 and SAO 140392 (452 and 392 for short). They are about 2° (roughly half a finder scope field) west of 8 Serpentis. Once you have those stars in your finder scope, you've arrived at Pluto's part of the sky.

In early April, placing 452 in your telescope's low-power eyepiece should put Pluto in the field. In late April and through May, center on 392. In mid-May Pluto passes only 1' south of 392.

Once you're there compare the detailed star chart on page 59 to the field of view in your medium-power eyepiece. This chart plots stars down to 14th magnitude; the circle on the chart indicates a field of view 0.5° wide, or the diameter of the Full Moon. If you are using an 8- to 12-inch telescope, Pluto will be among the faintest stars you can see. If you find a star that fits the description but isn't plotted on the chart, chances are that's Pluto.

To confirm your suspected find make a drawing of the field and return the next night. Don't wait longer than a few days. Relocate the field and see if your suspect star is still there. If it isn't, congratulations — you've confirmed your sighting of Pluto.

A Bonus Object

Now a warning: This year's Pluto hunt has an extra twist to it. You may come across another star in the area that also moves from night to night. Compared to Pluto this interloper is bright. If you discover a moving object of about 10th magnitude, you can add an asteroid to your list of finds. This is Juno, a 150-mile-wide asteroid. Throughout May Juno passes through Pluto's part of the sky. By a remarkable coincidence Juno reaches opposition only one day after Pluto. In addition, on the night of May 11/12 the two worlds are only 20' apart, with both objects close to 392, the 6.6-magnitude star we used to find them. This is a good opportunity for astrophotographers to nab both Pluto and an asteroid in one frame.

Aside from being the year of Pluto's anniversary and closest approach to Earth, 1990 is also the last year in the series of mutual eclipses between Pluto and its moon, Charon. Since 1985 Charon has been crossing in front of Pluto on every orbit, once every 6.38 days. This year Charon only partially eclipses Pluto, and next year Charon's orbit will be angled enough that it misses Pluto's disk altogether. Since this year's eclipses are only partial, the drop in Pluto's brightness during an eclipse is slight, less than 0.1 magnitude. This will require a photometer to detect.

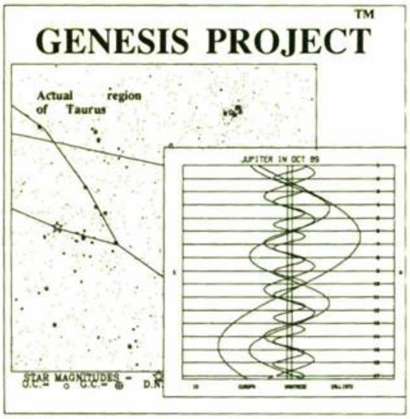
In all, Pluto is a world of challenges. With it now receding from the Sun, Pluto will be farther away from Earth during each year's observing window. If you've ever wanted to add Pluto to your list of finds, this spring is a prime opportunity — you'll even get an asteroid as a bonus! ☐

When to Look for Pluto

Date of New Moon	Observing Window
March 26	March 18-April 2
April 24	April 14-April 30
May 24	May 12-May 29
June 22	June 16-June 28

During these observing windows there are at least two hours each night when the Moon is out of the sky, the Sun is at least 18° below the horizon, and Pluto is at least 20° high through the two-hour period. These windows are calculated for a latitude of 45° North. In July and August Pluto will still be visible but will be low in the west at the end of twilight.

ASTRONOMY PRODUCTS SHOWCASE



GENESIS/LIGHT software includes pan, zoom, and mirroring of 8th or 10th magnitude starmaps, starting at $89.95, upgradeable to **GENESIS PROJECT.**

GENESIS PROJECT V2.0 software system includes support for laser printers and plotters, 10 projections of starmaps from a star database of over 250,000 stars, horizon and planisphere views, earthmaps, jupiter moon charts, wiremesh and contouring image processing, TM layout, graphics editor, over 150 page manual, and much more, $259.95. Requires an IBM XT, AT, 386, 486 or compatibles, graphics adapter. Shipping additional, available worldwide, NYS add appropriate sales tax. For FREE information, please call or write.

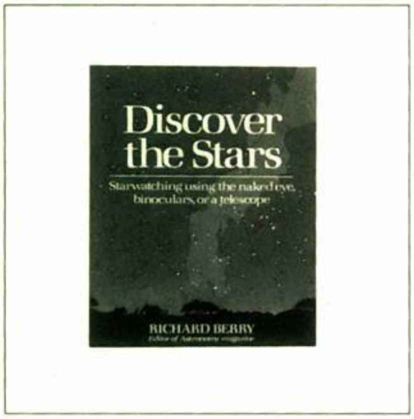
LEWIS-MICHAELS ENGINEERING
48 Delemere Blvd., ADA490
P.O. Box 248, Fairport, NY 14450-0248
(716) 425-3470

COPERNICUS
BINOC-U-MOUNT

BINOC-U-MOUNT™
"A STEADY PAIR OF HANDS BETWEEN YOUR BINOCULARS AND ANY TRIPOD"

BINOC-U-MOUNT is a patented quick mount from Innovative Energies which threads on quickly and allows you to instantly secure any size or type of hand-held binoculars to any type of tripod device. Simply rest your binoculars over the padded center and lash them down! Handmade in full grain leather, BINOC-U-MOUNT will lend a beautiful new look to your binoculars while stabilizing the view in any application. Available in three sizes: COMPACT, 4" base for small sizes ($35.00) - SILHOUETTE, 6" base for intermediate and most astronomical sizes ($39.00) — And COPERNICUS, 7" base for extra large sizes ($45.00). Satisfaction Guaranteed. Include $3 postage & handling.

INNOVATIVE ENERGIES INC.
50 Tower Road, Newton, MA 02164
(617) 332-1970 / (800) 542-7771


Discover the Stars
Starwatching using the naked eye, binoculars, or a telescope
RICHARD BERRY

DISCOVER THE STARS by Richard Berry

DISCOVER THE STARS leads you on a tour of all the stars and constellations visible with the naked eye and introduces you to deep-sky objects that can be seen with binoculars or a simple telescope. One section features twelve maps that show the entire sky overhead as it appears during each month. Another section consists of twenty-three star charts that depict smaller regions of the sky, providing names of key stars and showing double stars, variable stars, nebulae and galaxies. It's the perfect introduction to the heavens. 120-pages, paperback. #30155/ $10.95

Include for postage and handling: U.S. $1.50; Canada and Foreign add 15%. Wisconsin residents add 5% sales tax. (Minimum $3.00)

ASTRONOMY
Order Dept.
P.O. Box 1612
Waukesha, WI 53187

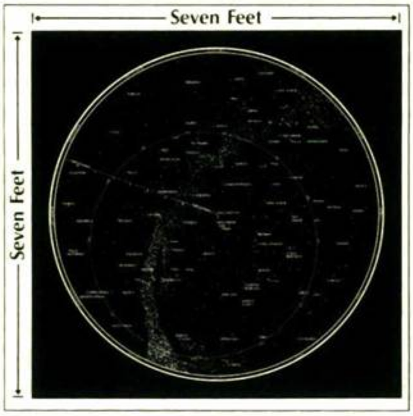
LEICA
8x42 BA

LEICA INTRODUCES A NEW GENERATION OF BINOCULARS

This new generation of sport optics equipment represents the fusion of form and function: the most advanced product construction containing the ultimate in optical performance. Leica binoculars offer: •True internal focusing •Completely waterproof and dustproof •Fingertip control of focus and diopter settings •One-piece, all metal construction •Extended viewing without eyestrain or headache •West German craftsmanship and engineering •Leica's exclusive 3 year, no-fault Passport Protection Program and Lifetime Warranty.

Call or write now for more details:

Leica USA Inc.
156 Ludlow Avenue
Northvale, NJ 07647
(201) 767-7500 FAX (201) 767-8666



Heavens Above™
Giant 7'X 7' Sky Mural!

Stars glow all night — over 500 of them, plus the Milky Way! Decorative and educational, **Heavens Above™** provides 49 square feet of the drama and excitement of the night sky to your home, office or school. By day, all constellations are named and outlined in white on blue; by night, the stars alone glow till dawn. Observing aid booklet and Space-Bond adhesive included; mural can be removed and remounted elsewhere. Oriented to 40° N Latitude. To order, phone toll-free 1-800-NITESKY, or mail check for $34.95 + $3 s&h (in NJ add 6% sales tax) to:

NIGHTSKY ENTERPRISES
Box 278
Pomona, NJ 08240
1-800-NITESKY

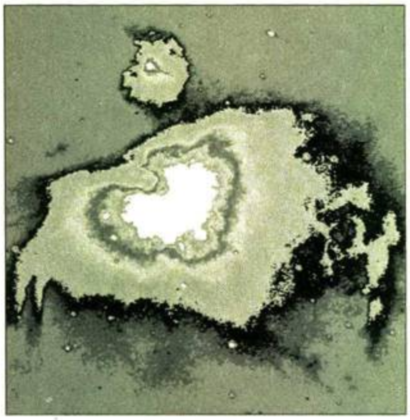
Compact Catadioptric Telescope from Swift Instruments, Model #854

Swift Instruments offers this optically excellent and beautifully finished compact Cassegrain telescope with equatorial fork mount. It comes packed in a handsome aluminum carrying case. Excellent pictures may be taken with this telescope by applying the correct "T-System Adapter" for your camera. Obtainable magnification is 133x, 64x, and 32x. Powers may be doubled by using a 2x Barlow Lens, available as an accessory. Aperture - 80mm, F.L. 1,000mm. Shipping weight 9 lbs.

Accessories included: a star diagonal, moon glass, 4 x 20mm finder scope, erecting prism, camera adapter, American Standard Eyepieces - OR6mm, K12.5mm, & K25mm. Complete with owner's manual.

Swift Instruments, Inc.
952 Dorchester Avenue, Boston, MA 02125
FAX (617) 436-3232

ASTRONOMY PRODUCTS SHOWCASE



AstroEnhance

State-of-the-art Computer Color Enhancing! Transform your B&W or COLOR astrophoto prints (sorry, no slides) into computer-enhanced false-colored images like those you see from NASA or JPL. The AstroEnhance imaging system utilizes sophisticated scanning technology to digitize your original astrophoto, then by computer magic is false-color enhanced and output as a fine-grain 35mm color slide from which enlargements can be made.

Send $3 for ACTUAL SAMPLE, ORDER FORMS and SPECIAL OFFER today! Or, order your AstroEnhanced images now. Send unframed B&W or Color prints (8X10 or smaller—sorry no slides) along with payment of $19.95* per AstroEnhance (add $2.50 for postage & handling) to:

AstroEnhance
719 S. Harbor Blvd., Drawer 222
Fullerton, CA 92632

For a view that's simply out of this world, it's Nikon binoculars.

They're clearly superior. All Nikons are built to last and utilize multicoated lenses, BAK 4 high index prisms, all-metal chassis, diopter adjustments to correct for common vision imbalance and are warranteed for 25 years. For the connoisseur, choose the ultra-fine optics of Nikon's coma-corrected 7x50 SP IF Prostar or 10x70 IF Astroluxe. Both are nitrogen filled and O-ring sealed for waterproof, fogproof integrity, perfect for the moisture associated with nighttime observation. For the astronomer with an eye on budget as well as quality, there's our Action Series 7x50 CF Owl and 10x50 CF Lookout, or our wider field, superfast-focus Gold Sentinel Series 7x50 Starvue and 10x50 Sentinel.

Nikon Inc.
623 Stewart Avenue
Garden City, NY 11530
(516) 222-0200

19MM WIDE FIELD

CUSTOM EYEGUARDS INCREASE CONTRAST!

For just $6 (postpaid U.S. only) you can update Tele Vue eyepieces with our new eyeguard. Fits the following models:

Plossl: 26, 21, 17, 13, 10.5, 7.4
Wide Field: 19, 15
Nagler: 7, 4.8 (specify)

This is the same eyeguard that is now standard on all these models. Great to minimize stray light and maximize viewing comfort. Send $6 each, $5 each for 3 or more, to: Tele Vue Optics, 20 Dexter Plaza, Pearl River, NY 10965 — Factory retrofits also available for 40mm space WF, 32mm WF; 13mm N, 9mm N; 55mm PL. Call Tele Vue for prices: (914) 735-4044

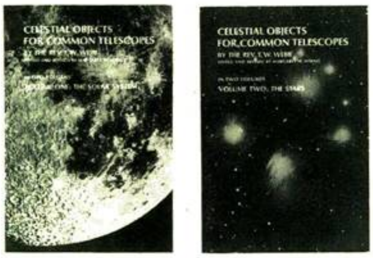
Tele Vue
20 Dexter Plaza
Pearl River, NY 10965

SATURN
THE RINGED WONDER
Solar System

THE COMPUTER GUIDE TO THE SOLAR SYSTEM™

This highly-acclaimed, easy-to-use software from WinterTech™ explores wonders ranging from nuclear processes in the Sun's core, to the herds of comets in the Oort Cloud. One critic raved, "*Graphically it is a piece of art... forget about time for awhile, it is that engrossing...*" See the structures of the Sun, Moon, and planets: their orbits revealed in dazzling 3D animations! Updated with info from Voyager's Neptune encounter! For novice and expert alike! IBM compatible version requires EGA or VGA color graphics. Atari ST version requires color monitor. Distributed worldwide. $54.95 plus shipping.

WinterTech™
111 Granada Court
Orlando, FL 32803
(407) 425-1199


CELESTIAL OBJECTS FOR COMMON TELESCOPES
CELESTIAL OBJECTS FOR COMMON TELESCOPES
BY THE REV. T.W. WEBB
VOLUME TWO, THE STARS

Celestial Objects For Common Telescopes

Over the years, *Webb's* has been a treasured source for thousands of observers. This 606 page classic covers the solar system in Volume 1, and deep-sky objects (grouped by constellation) in Volume 2. Valued as much for its style as for its content, *Webb's* is a book for every telescope owner. #30001/ $12.50

Include for postage and handling: U.S. $1.50; Canada and foreign add 15% (minimum $3). Wisconsin residents add 5% sales tax.

ASTRONOMY
Order Dept.
P.O. Box 1612
Waukesha, WI 53187

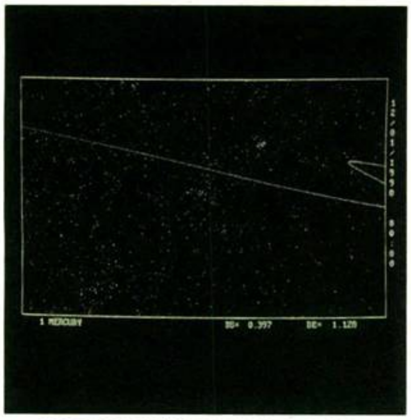
2415
24
HYPERSENSITIZED
FILM
4
ASTRO
PHOTOGRAPHY
11A
12

ATTENTION ASTROPHOTOGRAPHERS! G.M.R. purchases 2415 35mm B&W hypered film in bulk, passing the savings on to YOU. We stock KONICA SRV 3200 hypered film; provide processing & enlargement services on 2415 B&W film and offer custom hypersens. of 35mm film. Hypersens. film is shipped within 48 hrs.; processing & enlargements within 6 days. Send check or money order. Shipping & Handling included. (CA res. add 6.25% sales tax.)

2415 Fine Grain, B&W Hypered	15Exp.	$5.95
2415 Fine Grain, B&W Hypered	24Exp.	6.95
2415 Fine Grain, B&W Hypered	36Exp.	8.95
Konica SRV3200 Color Hypered	24Exp.	11.95
Konica SRV3200 Color UnHyp.	24Exp.	6.95
Cust. Hypersens. Film (we supply film)		12.95
Cust. dev. & proof of 2415 B&W film		9.95
Cust. B&W glossy 8"x10" print		8.95

G.M.R. PRODUCTIONS
P.O. Box 955, Pacific Grove, CA 93940
(408) 373-8021

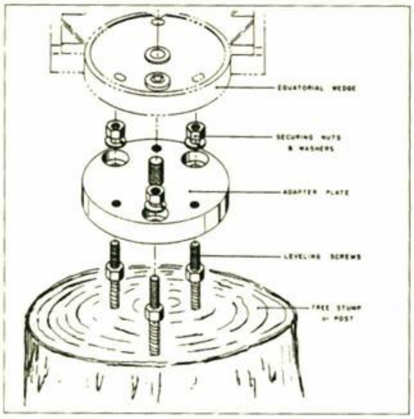
ASTRONOMY PRODUCTS SHOWCASE



FOR PEOPLE WHO LOVE ASTRONOMY.

ORBITCOM lets you track existing and newly discovered asteroids, comets and planets. Found a comet or asteroid? Use ORBITCOM to check your discovery. Generate an ephemeris (epoch 2000.0) for any object. Create finder star charts to use in the field. Display heliocentric orbital path or positions. Display the apparent path of any object across the sky. Complete online help screens. OGA, EGA, VGA graphics. Comes with tutorial, manual and 10 preconfigured demos from author including the new comet AUSTIN! Discover the sky with ORBITCOM. ORBITCOM is IBM compatible and an affordable $69.95. VISA and MasterCard accepted. Inquiries welcome.

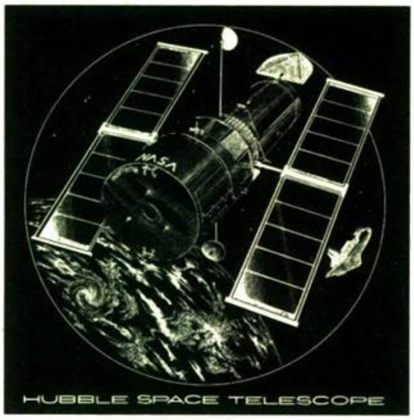
StarLogic Software
P.O. Box 17338
Jacksonville, FL 32245-7338
Call TOLL FREE (800) 628-0373



MOUNT YOUR WEDGE TO SOMETHING SOLID

Here's a relatively inexpensive way to have a permanent, rock solid, leveled pedistal onto which you can attach your Schmidt-Cassegrain equatorial wedge. The "Uni-pod" interface plate permanently mounts to the top of any 8 inch or larger wooden pole, post or tree stump. Besides giving you a solid mount, it also aids in faster set-up times and more consistently accurate equatorial alignments. This device remains outside so that when you are ready to set up for an observing or photo session, just attach your equatorial wedge to it — and you're ready to go! "Uni-pod" kit includes: aluminum interface plate, plated leveling & attaching hardware, installation instructions & suggestions, equatorial alignment procedure. $63.00 incl. shipping in U.S. (IN residents add 3.00 tax)

UNI-POD
2055 Marshall Drive
Valparaiso, IN 46383



Quality Imprinted Sportswear!

Hubble Space Telescope is one of many beautiful designs including The Horsehead Nebula, The Moon, A Space Walk, and A Shuttle. HST (#502) screen printed in 4 colors on high quality, heavyweight 100% cotton T-shirts and 50/50 heavyweight sweats. Color: Navy. Sizes: Sm, Md, Lg, XL. T-shirt (T502) $12.00; Long Sleeve T-shirt (L502) $18.00. Sweat (S502) $20.00. Payment (US $ only) MC/Visa, Ck., M.O. Shipping $2.50 1st item, $1 each add'l item, including Canada. Int'l $6.00 1st item, $3.00 each add'l. FL residents add 6%. A FREE catalog is available. Dealer and custom inquiries welcome.

Caledonian Graphics
P.O. Box 875, Dept. A
Zephyrhills, FL 33539
(813) 783-2434
(800) 223-4607

ACE • DOME

Shield yourself and equipment against wind, light and dew with ACE • DOME's portable, easy-to-assemble, personal observatory. Provides 360° rotation & zenith to horizon viewing. Durable & measures 7.5 ft. high x 12 ft. (diameter at the base.) Fits Celestron C-5 thru C-14, C-60 thru C-90; Meade Schmidt-Cassegrains, most reflectors & refractors; most 6" - 12" Newtonians f/8 or less.

Color: Royal Blue. Price: $149.00. Build-it-yourself kit: $79.00. (Add $5.00 shipping in USA & Canada, Foreign - $10.00) Free brochure available.

ACE • DOME
3186 Juanita
Las Vegas, NV 89102
(702) 873-5790

On a starry night the most convenient way to catch the constellations is with a pair of Minolta Binoculars. Our eight Standard models offer extremely bright, clear viewing — ideal for outdoor use! All feature superior multi-coated optics, water-resistant construction, sure grip rubber coating, and an easy to use center focusing wheel. For super high magnification the 10 x 50 is a sure choice.

Why not set your sights on a binocular with a 25 year warranty from Minolta... the company with 60 plus years expertise in optics? After all, when you go with the best the sky's the limit.

Minolta Corporation
101 Williams Drive
Ramsey, NJ 07446
(201) 825-4000

Optical Research Corporation

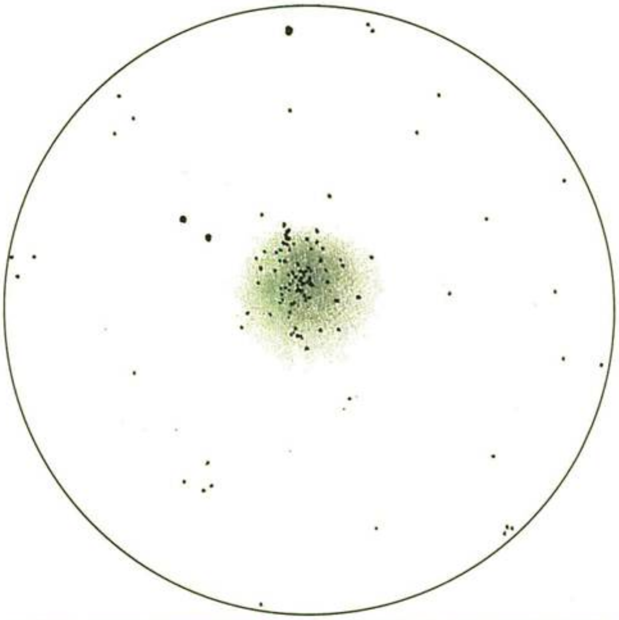
From the unique optical system to the integral triple-axis driven mount, the patented design of the Optical Research Newtonian telescope successfully unites short focal length image brightness with long focal length image quality to provide exceptional deep-sky *and* planetary images. Result: crisp low & high power images, minimal diffraction, variable magnification with one eyepiece, and a fixed, comfortable observing position. Available in 6" $1695; 8" $2195; and 10" $2995 (pictured). The lightweight aluminum/acrylic design of the Optical Research Filter Wheel is ideal for use on all telescopes. Both the 1.25" & 2" models incorporate a 2X Barlow eliminating focuser travel concerns & can hold eight 1.25" filters or four 48mm filters. 1.25" model $149; 2" model $169.

Optical Research Corporation
3009 E. Forest, Appleton, WI 54915
(414) 734-5006

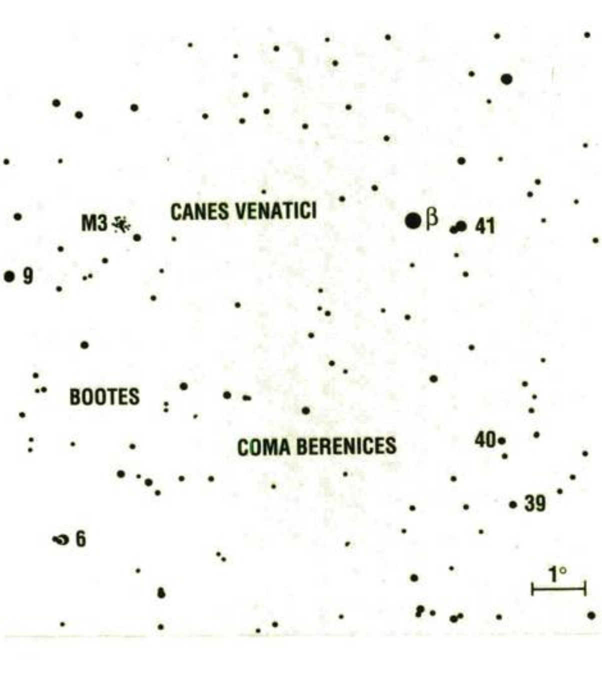
Five Challenging Globulars

Globular star clusters test your observing skills by making you perceive slight differences in star density, resolution, and brightness.

by David Higgins



M3
8-inch f/10 SCT at 50x Sketch by David J. Eicher



Objects predating the formation of our galaxy, globular star clusters are the ancient denizens of the universe. Composed of very old stars, globulars float like bees around the great central hub of the Milky Way in an irregular halo. In marked contrast to open star clusters, which contain up to several thousand stars, globulars pack in hundreds of thousands or millions of stars.

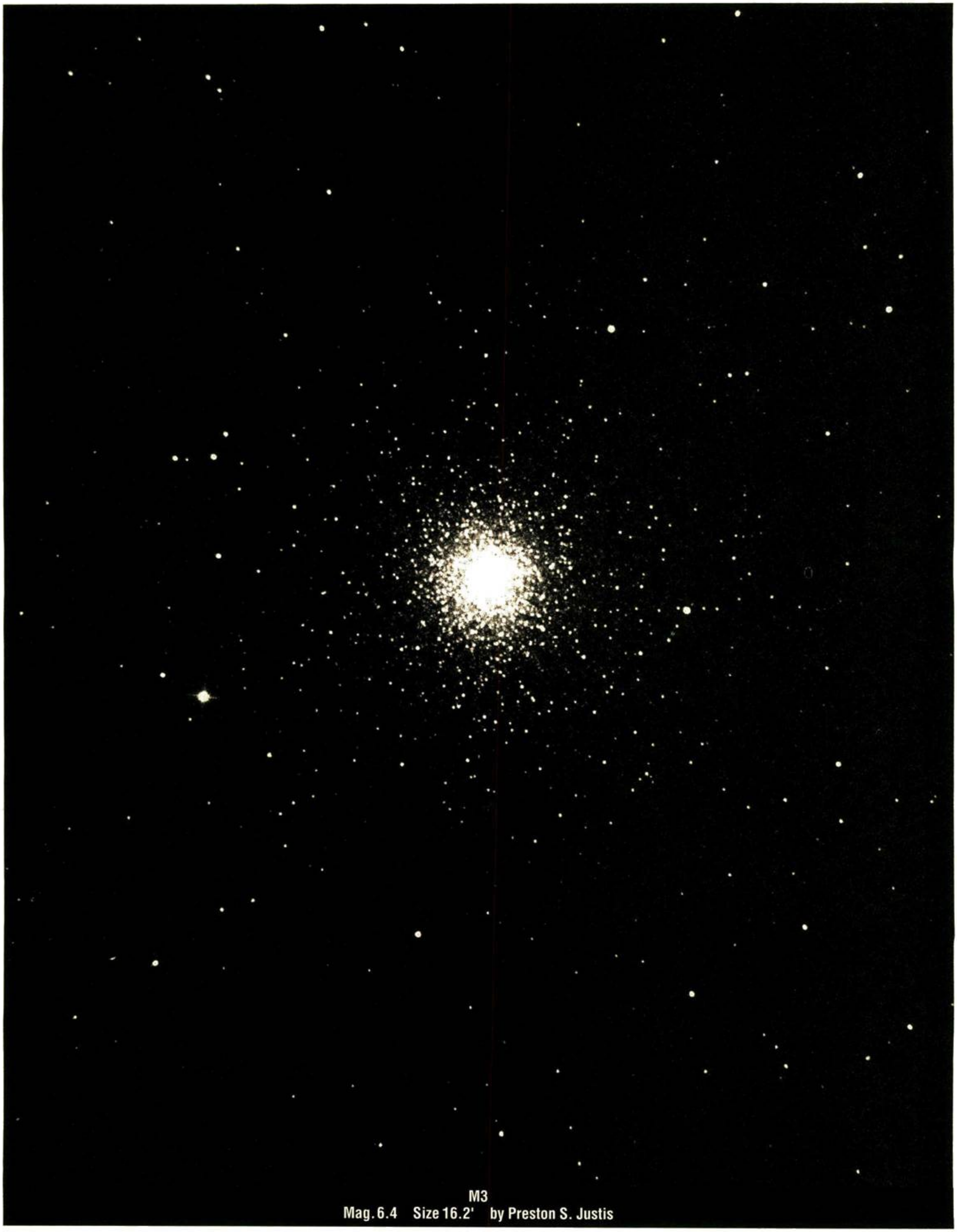
Because of the numerous red giant stars in globulars, most of these clusters are high surface brightness objects and are therefore easily visible in small telescopes. Some globulars, however, pose challenges for small scope observers. The reason may be low star density, a tightly compressed (and unresolvable) center, or simply a small apparent size. A handful of springtime globulars stand out as lures for those seeking a challenge.

The brightest and largest of the springtime globulars is **M3** (NGC 5272) in Canes Venatici. Shining at magnitude 6.4 and measuring 16.2' across, M3 ranks as the third brightest globular cluster in the northern sky. Estimated to be 10 billion years old, M3 is more than twice as old as our solar system. Generations of star formation and periodic dips through the plane of the Galaxy have removed virtually all of the gas and dust from this cluster, leaving a shell of old, yellow stars with empty space between them.

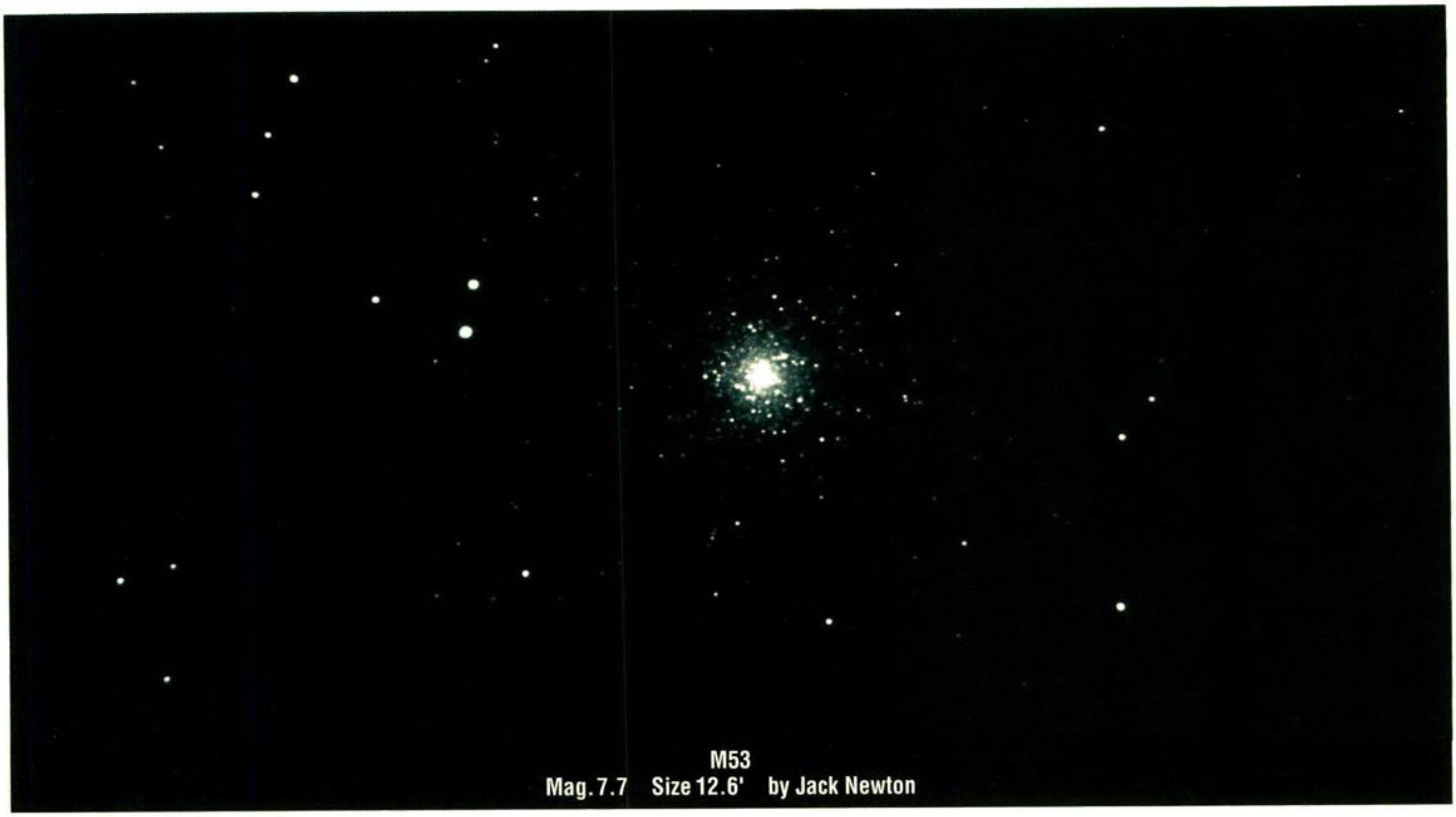
M3 is located in the southernmost portion of Canes Venatici. The easiest way to find it is to start by locating the 5th-magnitude star 9 Bootis. From there, sweep 2.5° northwest toward Beta Comae Berenices. On a dark night the fuzzy glow of M3 will be visible in any finder scope. If you're using a telescope smaller than 6-inches in aperture M3's core will not appear resolved. Instead, the cluster will resemble a large ball of gray-green light surrounding a bright, whitish core.

In a 6-inch telescope some resolution is possible, but the cluster's distinctive chains of stars are difficult to see with a 6-inch scope. A 12-inch telescope shows several strings of stars extending to the west of the cluster. Additional strings can be seen extending to the north and south. With high magnification you can resolve M3 almost to the core. The western half of the cluster is brighter than the eastern half.

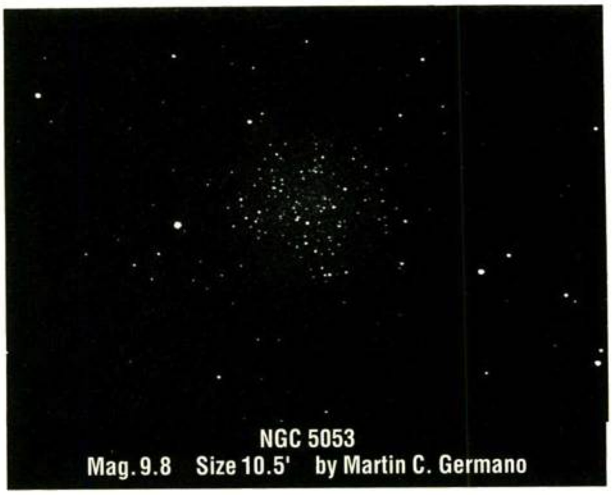
Large telescopes show M3 quite differently. With high magnification the cluster's core is resolved into hundreds of stars spread uniformly across the face of the cluster. The strings of stars that extend to the north



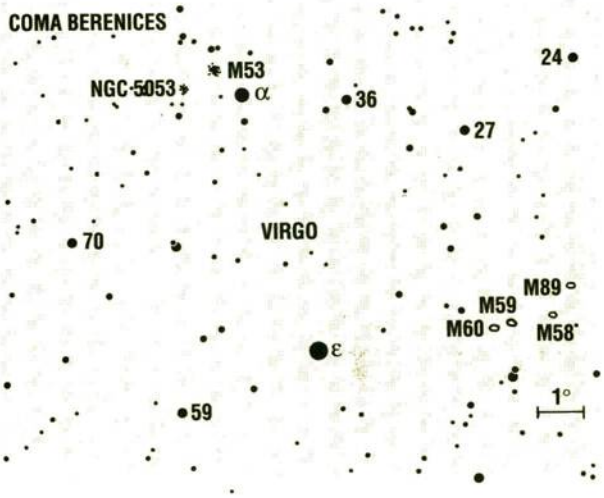
M3
Mag. 6.4 Size 16.2' by Preston S. Justis



M53
Mag. 7.7 Size 12.6' by Jack Newton



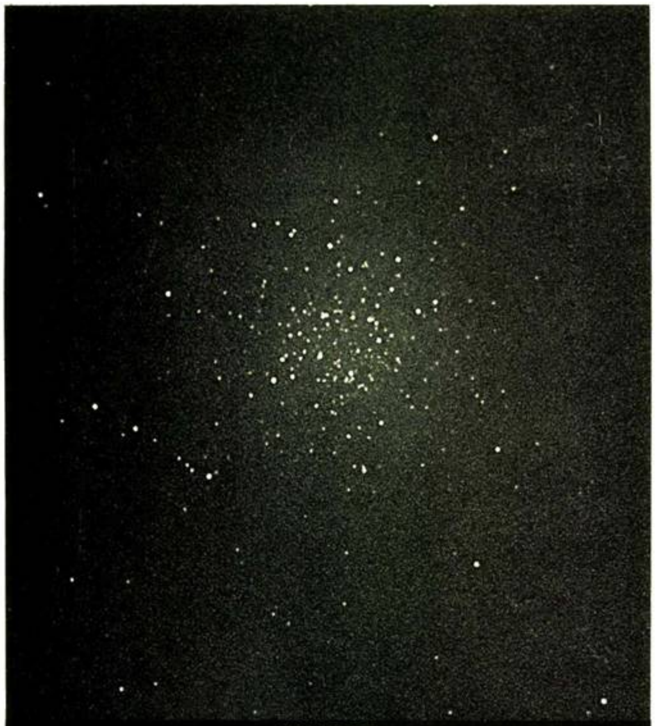
NGC 5053
Mag. 9.8 Size 10.5' by Martin C. Germano



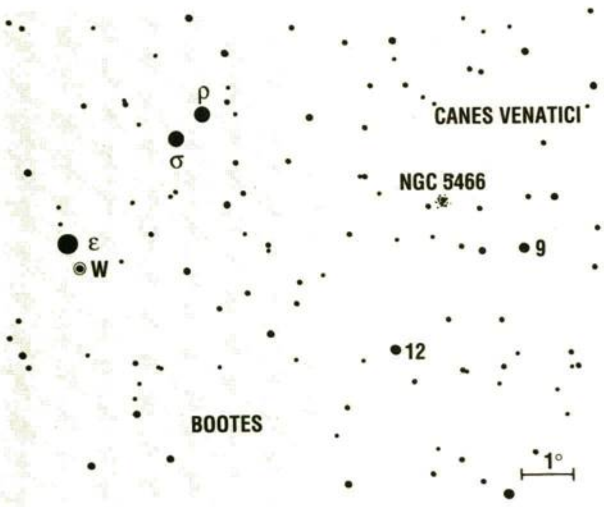
and south are much more pronounced. The strings extending to the west are brighter and more noticeable. One in particular extends about 5' to the west and then suddenly makes a 90° bend to the north, coming to an end at a bright field star. Telescopes in the 17-inch class and larger give the cluster the appearance of being extended north and south. Several loops of stars can be seen extending north and south of the cluster, but the eastern edge lacks star chains or loops.

Large and loose **NGC 5466** in Bootes is very faint and has an extremely low surface brightness. Although it glows at 9th magnitude and measures 11' across, the stars in NGC 5466 are scattered and sparse. Because the group lacks a bright central condensation, you have to see some of its brightest individual stars in order to view the cluster. To hunt it down start back at 9 Bootis but this time sweep 2° to the northeast. Use a low-power, wide-field eyepiece.

Small telescopes show NGC 5466 only as a faint haze. Little structure or detail is visible even at high magnifications. With a 6-inch scope at 100x NGC 5466 appears like a weakly glowing disk that stands out only marginally from the sky background. Higher powers reveal a hint of resolution. At 200x the amorphous glow seems peppered with knots that during moments of extraordinarily good seeing snap into focus as little groups of pinpoint stars. The effect is visible only with averted vision, however. A 10-inch telescope is required to routinely resolve the cluster's brightest members. With this aperture NGC 5466 appears as a disk of greenish light with a dozen or more tiny stars suspended in the glow. In a 12-inch scope the view is more distinct. At low magnifications the cluster's glow stands out well from the sky background. At high magnifications two dozen or more stars are visible, including a prominent string of stars



NGC 5466
Mag. 9.1 Size 11.0' by Martin C. Germano



that extends outward from the cluster's eastern edge.

Coma Berenices contains three spring globular clusters. **M53** (NGC 5024) is the largest and brightest of the three. Although not as large or impressive as M3, it is nearly as bright. Easily visible in a finder scope, M53 can be found by starting at Alpha Comae, the brightest star in Coma Berenices. Using low magnification, sweep 1° to the northeast and M53 will show up in the field of view. In small telescopes the cluster appears as a large, bright cometlike ball with a bright middle that gradually fades outward. In a 6-inch scope it appears partially resolved around the edges and shows a sprinkling of stars. A 12-inch scope at high magnification resolves part of the core into a mass of individual stars. At lower magnifications a chain of stars on the eastern edge extends north and south.

In a 17.5-inch scope at high power M53 becomes a mass of twinkling fireflies. The core is resolved with strings of stars extending outward from the northern and western edges. A few loops of stars are visible at low magnifications. A solitary bright star floats on the northern edge of the cluster.

A faint neighbor of M53 offers an extreme challenge. **NGC 5053** lies about 1° southeast of M53 and can be glimpsed as a faint hazy spot in telescopes equipped with low-power, wide-field eyepieces. Don't expect to see this one in a finder scope. NGC 5053 glows at magnitude 9.8 and measures 10.5' across. In 6-inch or smaller telescopes the cluster is hard to find and does not offer any detail other than a faint haze. A 12.5-inch scope provides a view of NGC 5053 that almost resembles an extremely rich open cluster, with a sprinkling of stars across the face of the cluster. Large telescopes show a central concentration of stars. The cluster is irregular in shape and gives the impression of a misshapen triangle oriented roughly east-west.

Our final challenging globular lies in the corner of Coma Berenices. **NGC 4147** is situated on the northern edge of the Virgo Cluster of galaxies, causing some confusion about its identity when viewed with a finder scope. To find this faint cluster start with Beta Leonis and 93 Leonis. From a point midway between the two stars extend a line eastward for about 8°. Now you will see the 5th-magnitude star 11 Comae Berenices. These three stars form a triangle that is easy to see from a dark-sky site. From 11 Comae Berenices extend a line northwestward 2.5° degrees toward 93 Leonis. This point marks the location of NGC 4147.

NGC 4147 is very small compared to M3. NGC 4147 shines at magnitude 10.3 and measures 4' across. Small telescopes do not resolve the core but they do show a bright central region that gradually fades outward. A 12-inch scope doesn't resolve the core either but some stars are visible on the cluster's edges. In larger scopes the core appears starlike due to its great brightness. The cluster's edges are resolved into stars although no strings or loops are visible.

Who says springtime observing has to mean galaxies? Try a change of pace by observing some objects that belong to the good ol' Milky Way. Although the spring sky holds fewer globulars than the richer region of the summer Milky Way, the springtime clusters challenge your observing skills. Try them on the next clear night and you'll be amazed at the variety and beauty of these ancient celestial gems. ☐

Challenging Spring Globulars

Object	R.A.(2000.0)Dec.	Mag.	Size
NGC 4147	12h10.1m +18°33'	10.3	4.0'
M53 (NGC 5024)	13h12.9m +18°10'	7.7	12.6'
NGC 5053	13h16.4m +17°42'	9.8	10.5'
M3 (NGC 5272)	13h42.2m +28°23'	6.4	16.2'
NGC 5466	14h05.5m +28°32'	9.1	11.0'

Object: Designation in Messier or NGC catalog. **R.A. and Dec.:** Right ascension and declination in equinox 2000.0. **Mag.:** V magnitude of cluster. **Size:** Diameter in arcminutes.

David Higgins is central coordinator of the National Deep Sky Observers Society and a contributing editor of Deep Sky magazine.

"CLIP AND SAVE"

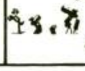
WHO BUYS FROM WHOLESALE OPTICS . . .

PERKIN ELMER SPACE TELESCOPE MFG'R. PURCHASED CELESTRON C5, C8, C11 & EQUIP.

DANBURY, CT

PUT YOUR TRUST IN US
THE PROFESSIONALS DO

IMPORT
EXPORT



OVER 300 SCOPES PLUS
1000 ACCESSORIES IN STOCK
ALL MAJOR BRANDS

**MEADE — CELESTRON — BAUSCH & LOMB — BUSHNELL
BRANDON/VERNONSCOPE — UNIVERSITY OPTICS — JASON — VOGEL/DIGITRACK
MUSSER — DAVIS & SANFORD — J.M.I. — KOWA — FUJINON — STEINER
ADLERBLICK — 1000 OAKS — NIKON — SWIFT — MIRADOR — EDMUND
SCIENTIFIC — VIXEN — PARKS — LOSMANDY — ZEISS — SWAROVSKI — ETC.**

CELESTRON

TELESCOPES	
NEW Ultima C11 w/wedge & tripod	$2939
Ultima 8	$1749
SPC8 w/Starbright	$1075
CLASSIC 8 w/Starbright	CALL
Special SC8 +	$989
C040 (Great for the kids)	$59
60mm Alt-Azimuth Refractor (C60)	$139
(C60E)	$259
Firstscope 80	$455
SP-C80 $599 Fluorite (SP-C80F)	$1395
Refractor (SP-C102)	$995
Fluorite Refractor (SP-C102F)	$2049
C4.5	$425
SPC6	$699
SPOTTING SCOPES	
C90 Custom $295 C-90 $349 C-90 M/C	$399
C90R $405 C90 Astrotelescope - Brass	$995
C90R M/C w/black rubber covering	$445
Super C90 Conversion Kit	$139
C60R	$219
C-65	$189
Zoom Master II	$289
SS80	$305
Photographic Tripod $89 Mini Tripod	$30
Shoulder Mount	$79
BINOCULARS	
Monocular 8x25	$39
Mini Binoculars 8x25	$65
Classical 7x35 $89 7x50 Extra Wide Field	$99
10x50	$109
Ultima 7x42, 8x32 $185 ea. 10x50	$209
Giant 16x70 $219 11x80 $295 20x80	$299
Deluxe 14x80 $449 14x100 $895 20x100	$895
25x125 $2395 10x70 $219	
OPTICAL TUBE ASSEMBLIES	
C80	$279
Deluxe 8" Optical Tube Assem. w/Starbright	$695
14"	$4239
EYEPIECES	
.96" OR 4mm, 5, 6, 7, 9, 12	$36 ea.
.96" KE 10mm, 16, 18, 25, 30, 40	$33 ea.
Zoom .96" OR 8.4-21mm $65 Zoom Deluxe	$96
7-20x $89 Terrestrial Eyepiece .96"	$17
25mm K 1¼ $33	
OR 1¼" 4mm, 5, 6, 7, 9, 12, 18, 25	$45 ea.
ER 1¼" 20, 24, 28mm	$52
PL 1¼" 7.5mm, 10, 17, 26	$65 ea.
PL 1¼" 22mm $69 30mm $70 36mm, 45mm	$73 ea.
Zoom OR 1¼" 8.4-21mm	$89
Ocular-2" 32mm ER, 50mm PL	$99 ea.
18, 25, 32, 40, 50mm OR 2"	
SPECIAL PURCHASE 60mmK 2"	$74
T-RINGS	
(State Camera Make-Model) All $10 EA. (2) FOR 18	
ACCESSORIES	
Accessory Case	$40
Barlow Lens 2x .96", 2.5x .96", 3x .96"	$29 ea.
Barlow Lens 2x 1¼"	$39
Barlow Lens - Deluxe 2x-1¼", 2x-2"	$75 ea.
Binocular Tripod Adapter	$15
Car Batt. Adapter Powerstar, Ultima	$14 ea.
Car Window Mount	$50
Carrying Case - Powerstar 8	$125

Carrying Case - C90	$54
Counterweight Bar Assem. - 8" $94 11"	$98
Counterweight Set - 8"	$48
Diag., Erect Image - 45°-.96" $44 45°-1¼"	$48
45°-.96" to 1¼"	$45
DEC Motor - Powerstar, Ultima 8/Classic 8	$85 ea.
DEC Motor - 11"	$75
DEC Motor C8, Sup. C8	$75
Deluxe Lat. Adjuster (DLA) C8	$30
Dewstar (Lens Shade - 8")	$19
Digital Setting Circles - for C8 fork mounts, Ultima 8	$294 ea.
Digital Setting Circles (Astro Master) - for S.P.M.T.	$323
Advanced Astro Master	$629
Drive Corrector - Heavy-Duty $329 Quartz Sing. Axis	$159
Quartz Dual Axis	$249
Expanding Bushing - .96" to 1¼"	$14
Filter Set (6) 2"	$72
Filters #1A, 8, 12, 15, 21, 23A, 25, 38A, 47, 56, 58, 80A, 82A, 96ND-50%, 96ND-25%, 96ND-13%, Polarizing	$12 ea.
Filter Sets (Set of 6) $69.50 (Set of 12)	$131
Filter Adapter - .96" $12 1¼"	$14
Finderscope 8x20 for C90-erect image	$54
Finderscope R/A 5x24 $39, R/A 6x30 $45, 6x30	$29
8x50 $45, 8x50 R/A $85, 16x70 R/A w/pol. ill.	$189
R/A w/Polar Align. Reticle - 8x50	$129
Focus Motor - 11/14"	$89
Focus Motor w/Hand Control Box - Ultima 8, Powerstar, Clas. 8	$75
Focus Motor - C8, Super C8	$85
Guidescope 700/60 w/brackets	$209
Hand Controller - Ultima 8/11	$79
Illum. Ret. Ocular Assem., DBL Line	$84
Battery (Silver Oxide)	$3
Illum. Projection Reticle - 1¼"	$134
Image Corrector - 1¼" C90-C60	$42
Large Accessory Ring (LAR)-C90	$19
Lens Shade - C90	$45
LPR Filter (Nebular) #2 $129 #3 $42 #5	$79
#7 $89, A $66, B $94, C $119	
Motor Drive - for C4.5 w/Dr. Single Axis - SP	$152 ea.
Motor Drive w/Dr. Dual Axis - SP	$242
Multiple Ocular Holder - .96" $75 1¼"	$115
Off-Axis Guiding System $142 Guider Body (Only)	$59
Photo Tripod Adapter - 8"	$50
Photographic Tripod Deluxe Slow Motion Controls	$43
Piggyback Mount - 8" $33 11/14	$44
Piggyback Mount - SPC80, SPC102, SPC6	$39 ea.
Polar Axis Finder w/illum. (for C4.5)	$48
Polar Axis Finder - SPC6 - C80	$66
Polarizing Filter Assem. (Rear Cell)	$99
Polar Filter Set - .96" $36 Polarizing Filter Set - 1¼"	$42
Porro Prism - .96" $39 Porro Prism - 1¼"	$43
RFA (Rich Field Adap.) $99 RFA (w/o eyepiece)	$55
Refractor Accessory Ring	$18
Reducing Bushing = 1¼" to .96"	$16
Filter Set - Series 5 $45 Series 6	$54
Sky Sensor $495 Sky Sensor AC per. supply	$95
Skylight Filter Model #1 (C90's) $31 #2 (8/11/14)	$33
Solar Filter - C90 C102	$59
Solar Filter - C8 $89 8" (C14)	$109
5" Off Axis - C-11 $99 C60 C80	$38
Star Diagonal - .96"	$22
1¼" w/Multicoatings $40 2" - Heavy Duty - 8/11	$209
2" - Widestar - 8/11 (w/1¼" adapter)	$109
Stereo Binocular Viewer	$449
Super Polaris Half Pier	$93

T-Adapter (8/11/14), Refractors/SS80/C4.5, C-90, Zoom Master/C60 Rubber Spotting Scope	$28 ea.
T-Adapter/Tele-Extender - 60mm Refractors	$35
T-C 16mm Adapter	$28
Table Top Mount - C65	$20
Tangent Assembly	$279
Tangent Frame - 11", 14"	$59 ea.
Tele-Compressor	$50
Tele-Extender $28 T-Adapter (Refractor/Newt.)	$38
Tripod - Adjustable 8" $179 8" Armored	$199
Photo $89 11/14	$468
V.S.P. (Vibration Suppression Pads)	$46
Visual Back - 1¼"	$26
Wedge-C90, 5, 8 $74 Heavy-Duty 8" $198 11/14	$365
PUBLICATIONS	
Owners Manuals	$5 ea.
Telescopes for Astronomy Booklet & Telescope Booklet	50¢ ea.
Accessory Catalog	$3
Spotting Scope Booklet & Binocular Booklet	50¢ ea.
Product Guide and Reference Manual Book	$14
Sky Maps	$12
Star Atlas 159 pgs. (Northern Hem.)	$10
MISCELLANEOUS	
Slide Sets 35mm #1, 2, 3, 4 $15 ea. Set of 4	$55
Schmidt Camera Film Holder	$129
C90 Eye Piece Holder - Visual Back 1¼"	$29
Trans Star-Tripod Wheels (3)	$39
Lens Caps	$.50 ea.
Brass C50 (DMO)	$159

MISCELLANY LIST

Edmund Astro Scan 2001	$282
Tele-Rad (with FOG-X)	$38
Kaleidoscope - Brass	$95
Steiner 10x50 Binoculars	$259
Lunar Clock - Electric	$59
Equatorial Mount for Spotting Scope	$95
KOWA TS601 (45°) Spotting Scope	$239
Adlerblick 7x50 OR - 10x50	$219
Unitron - Astro Camera 4x5	$299
Vogel - Digitrak Drives, Inverters, Batt-PKS	CALL
Questar Tripod	$239
Swift Binoculars, Spotting Scope	cost - plus
Edmund Inspection Mirror	$12
Photo Tech Straps (for binoculars)	$2

Lumicon Close Out — Call

**THOUSAND OAKS SOLAR FILTER
TYPE I, II, III CALL!
USED SCOPES - EQUIP., LIST**

SEND S.A.S.E.

**AWARD 1989
As One of the
Fastest Growing
Firms in America! #452**

BAUSCH & LOMB

— REINTRODUCED —

ASTRO 4000 $449
PRO 4000 KIT $499

4000
TELEPHOTO
$249
(1200mm)

8080 $198
(800mm)

UNBELIEVABLE PRICE!

8000
8¼"
Sch/Cass
$595

8000 PRO $699
8001 $795
(220V-50HZ Avail.)

Wedge/Tripod
$199

SPOTTING
SCOPE
4000 SS
4" Sch/Cass $349

REINTRODUCED
6000
6" Sch/Cass
$695

BAUSCH & LOMB ACCESSORIES

PROFESSIONAL SERIES PL OCULARS 26/ 35mm $49 ea./ SYMMETRICAL 7/ 9/ 12.7/ 18/ 30mm $33 ea./ 4.6mm OR $45/ ZOOM ORTHO 8.3-21mm $79/ 16.3mm ER $49/ 32mm PL $49/ 50mm HASTINGS $45/ 50mm RAM $29. FILTERS - SERIES 6 DROP-IN SET (6) $49/ DRIVE BASE/FORK TINES 4" $199/ WEDGE/TRIPOD (4000) $129/ WEDGE/TRIPOD (6000-8000) $224/ FINE LATITUDE ADJUSTER $29/ S.S. CONVERSION KIT $110/ EYEPIECE ADAPTER $28/ PORRO PRISM $45/ BARLOW LENS 2x $29/ RFT ASSY $79/ FINDER SCOPE BKT for 4000 $29/ 4x FINDER (4000) $20/ STAR ATLAS BOOK, NAKED EYE TO DEEP SKY $9/ 6x30 FINDER $39/ 8x50 FINDER (8000) $47/ MEASURING RETICLE EYEPIECE $45/ EYEPIECE PROJECTION TUBE (TELE. EXTENDER) $29/ PIGGYBACK MOUNT (4") $21/ (6 and 8") $29/ C'WEIGHT SET (6-8") $59/ OFF AXIS GUIDER BODY. $139/ B&L TO OTHERS ADAPTER $29/ CAMERA ADAPTER 1¼" OR .96" $19/ F-5 FOCAL REDUCER #1 $29/ F-7.5 FOCAL REDUCER #2 $39/ SOLAR FILTER (4000) $95/ CAMERA ADAPTER, CFA (PRIME FOCUS) SCH/CASS 4", 6", 8", $30/ (4000) OWNER'S MANUAL $10.

**WE ARE THE NATIONS "LARGEST BAUSCH & LOMB TELESCOPE DEALER" 2nd to none.
ALL ITEMS ARE IN STOCK FOR FASTEST DELIVERY POSSIBLE!**

HARBOURMASTER (BRASS) 18th CENTURY COPY	$1695

Meade

97 D, 97 E, 97 ERII, 97 EII, Spotting Scope	from $318
Pathfinder II $185 SN6	SPECIAL
"16 NEW MODELS" 2080-2120/30-50-70 CALL OR FORWARD S.A.S.E. for List	
312: 3.1" (80mm) f/11 Alt. Refracting Telescope	$395
323: with Equatorial Mount	$524
226: 2.4" (60mm) Alt. Refracting Telescope	$148
291: 2.4" (60m) Equatorial Refracting Telescope	$288
#228 2.4" BRASS CALL #314 3.1" BRASS	CALL
826C 8" f/6 Newt. w/Motor Dr. and equatorial mount	$889
New 2045D $639 Case	$55
1060: 10" f/6 Reflecting Telescope Research Series	
1266: 12" f/6 Reflecting Telescope Research Series	
DS-10A: 10" f/4.5 Reflecting Telescope incl. MOTOR.	
DS-16A: 16" f/4.5 Reflecting Telescope incl. MOTOR.	
11x80/20x80 Black Rubber Cov. Binocs.	
4420 (NEW) 4¼" Refl.	$349
(All Telescopes — Call For Best Available Price)	
Equatorial Wedge plus Tripod 2045	$209
Super Wedge 10" w/Trade	$299
Equatorial Wedge for Model #2080	$78
Equatorial Wedge for Model #2120	$98
Field Tripod for Model 2080, 2120	$219
Altazimuth Adapter for Field Tripod (2080, 2080 LX3)	$28
#68 Table Tripod	$46
Deluxe Latitude Adjuster: 2045, 2080, 2120	$28
Setting Circle Illuminator System: 2080, 2120	$38
L.E.D. Map Light: 2045, LX3, 2080 LX3, 2120 LX3	$27
#605 Magnetic Compass (for attachment to equatorial)	$20
#607 25' Extension Cord for use with AC Converter	$16
Azimuth Control (for Field Tripods for Model 2080)	$28
#603 DC Cord (25') w/cigarette plug	$16
#604 AC Converter w/25' Cord	$26
#1200, 1200A Electric Focuser — NEW "90"	$189
#671 Wide-Field Adapter System (WFAS complete)	$99
Tele-Compresser Lens only	$39
Tele-Compresser System comp. w/Extender Tube	$57
Eyepiece Extender Tube only	$16
Off-Axis Guider Body only	$59
Off-Axis Guider Assembly comp. w/illuminated	$132
#419/#427 Illum. Ret. Eyepiece System .965", 1.25"	$79
#702A Double Crossline Reticle	$24
#705A Micrometer Reticle	$26
Alternate 1.25" Barrel for 3427	$10
Alternate .965" Barrel for 419	$10
Spotting Scope adapter Plate: 2080, 2080 LX3, 5 & 6	$40
H35mm Crosshair Eyepiece (.965)	$36
R9mm Crosshair Eyepiece (.965)	$36
Spotting Scope Adapter Plate: 2120, 2120 LX3, 5 & 6	$52
Mod. Ach. (.965) 9, 12, 25, 40mm	$34

Ortho Res. Grade 7mm 1¼"	$47
40mm Mod. Achromatic ep., 1.25"	$39
.965 Orthos: 4mm, 6mm, 9mm, 18mm Oculars	$39
1.25" Orthos: 4mm, 6mm, 9mm, 12.5mm & 18mm	$46
Sup. Plossl 1.25":	
6.4mm, 9.7mm, 12.4mm, 15mm, 20mm & 26 Oc	$69
32mm, 40mm	$83
56mm	$159
13.8mm Super Wides 1.25"	$116
18mm 1.25"	$123
24.5mm 1.25"	$128
32mm 2"	$196
40mm 2"	$255
4.7mm 1.25"	$130
6.7mm 1.25"	$158
8.8mm 1.25'/2"	$184
14mm 1.25'/2"	$198
Rotary Multiple Holder	$99
Eyepiece Holder, 1.25"	$26
#915 Diagonal Prism .965	$36
#917 Hybrid Diagonal Prism (.965/1.25)	$36
#918 Diagonal Prism 1.25"	$36
#919 Diagonal Prism w/threaded Ring 1.25"	$36
#929 2" Diagonal Mirror including	
eyepiece adapter w/1¼" Adapter	$99
#930 2" Diag. Mirror, 2" OD Barrel for	
2" Focuser Sleeve	$99
#926 Image Erecting Lens (220, 226)	$19.50
#924 Erecting Prism 1.25"	$56
#928 Erecting Prism System 45°	$46
#912 Roof Prism .965 90B, 97D, 97E, 97ER	$66
#928 Erect-Image Roof Prism	$49
#931 Hybrid 45° Erecting Roof Prism	$49
Photo Visual Color Filters & Polarizer	
.965" 1.25" All Col. Avail.	$12
Set of 6 Photo Visual Color Filters (#8, 23A, 58)	$71
Set of 6 Photo Visual Filters (.965) Thread In	$71
Series VI Drop-In Filter Set 102, 107D	$56
Series V Drop-In Filter Set 90B, 97D, 97E, 97ER	$46
Nebula Filter #908 1.25	$59
#911 Nebula Filter (rear cell Thread on)	$105
#122 2X Tele-negative Amplifier (for all 8" & 10")	$40
#127 2X-3X Variable Tele-negative Amplifier	$57
#131 2X Tele-negative Amplifier .965 (291, 294)	$36
#140 2X Tele-negative Amplifier (for all 8" & 10")	$62
#581 Sun Shade 90B	$46
#582 Dew Shade for 107D, 2045	$46
#710 Dew Shield 10": 2120	$92
#712 Dew Shield 8": 2080	$56
#905 Variable Polarizing Eyepiece System 1.25"	$48
#910 Nebula Filter 2"	$104
#1A Skylight Filter/Dust Seal	$44

#50 Accessory Case	$59
#54 Accessory Case	$20
Extra 2lb Weights for 1401 or 1402 each	$16
#1401 Tube Balance Weight System 2080	$80
#1402 Tube Balance Weight System 2120	$85
Extra Counterweight 25lb: 880, 1060, 1266	$66
Extra Counterweight 40lb: 880, 1060, 1266	$86
#300 PG 3.1" Photo-Guide Telescope:	
Deluxe & Research	$286
#280 PG 2.4" Photo-Guide Telescope:	
Deluxe & Research	$126
#214 PG 2" Photo-Guide Telescope: Deluxe & Research	$125
#210 PG 2" Photo-Guide Telescope: Deluxe & Research	$86
#67 Focuser 1.25" I.D.	$46
#640 Focuser 1.25" I.D.	$72
#680 Deluxe Focuser 1.25" & 2" I.D.	$94
#59 Photo Adapter Pathfinder only	$18
#60, #62, #61, T-Adapters	$29
#64 T-Adapter only, for WFAS	$34
Tele-Extender	$28
Basic Camera Adapter 1.25", .965"	$39
Variable Projection Camera Adapter 1.25"	$45
2" Prime Focus Adapter	$39
Prime Focus Camera Adapter (277)	$20
T-C Movie/Video Camera Adapter	$26
T-Mount Camera Ring Adapters	
(Spec. Camera & Model)	$10
Extension Tube Set (15mm, 30mm, 45mm)	$39
#708 Piggyback Camera Adapter (310, 320)	$36
Piggyback Bracket: 2080/2120	$32
Piggyback Bracket: 2045, 2045LX3	$16
#630 6x30 Right Angle Viewfinder 622	$46
#631 6x30mm View Finder w/bracket	$46
#539 8x50 Polar Illuminated View Finder w/bracket	$99
#967 9x60 Polar Illuminated View Finder w/bracket	$124
Bracket for #541 View Finder	$12
#632, #637 6x30 View Finder w/bracket — MTS	$42
#545 8x50 View Finder w/bracket — SN6-8	$73
#544 8x50 View Finder w/bracket — SC8	$76
Mounting Brackets (2.38") or (3.6" I.D.)	$22
#781 Electric Motor Drive, AC use with #100	$89
#787 Electric Motor Drive System (DS-10)	$96
#897 Electric Motor Drive System (DS-16)	$187
#788 Electric Motor Drive	$118
#790 LX3 Quartz Electronic Dr. System/Hand	
Controller	$359
#55 Manual Declination Control 628C, 645C, 826C	$56
#65RS Manual Declination Control 880, 1060, 1266	$106
#48RS Dual Axis Drive Corrector System 880, 1060	$296
#36 Single Axis-Dual Axis Drive Corrector Control	$80
#38 Declination Motor Assembly 2080LX3, 2120LX3	$75
#43 R.A. Drive Corrector operates from 12VDC	$79
#46 Dual Axis Drive	$229
#47M Dual Axis Drive Corrector System 628C, 645C	$246
#38A Declination Motor Assembly 2045LX3	$80
#38B Declination Motor Assembly 2080, 2120	$80
#38M Electric Declination System	$74
#39 Declination Motor for LX5	$89
#9000: for all Meade 2080 Models	$839
#9000-RS: for all Meade 2080 Models w/CAT-COM	$979
#9001: for all Meade 2120 Models	$839
#9001-RD: for all Meade 2120 Models w/CAT-COM	$979
#9003: for C8 fork-mount models	$839
#9003-RD: for C8 Models w/CAT-COM	$979

#9005: for C11 Models	$839
#9005-RD: for C11 Models w/CAT-COM	$979
#9007: for German Mounts	$1024
#9007-RS: for German Mounts w/CAT-COM	$1169
#9060: D.S.C. for Meade 2080 Models	$399
#9061: D.S.C. for Meade 2120 Models	$399
#9063: D.S.C. for C8 fork-mounted Models	$399
#9065: D.S.C. for C11	$399
9008: CAT for 2080/LX6	$839
9008-RS: CAT for 2080LX6 w/CAT-COM	$979
9010: CAT for 2120 LX6	$839
9010-RS: CAT for 2120/LX6 w/CAT-COM	$979
9068: Digital Readout System for Model 2080/LX6	$339
9070: Digital Readout System for Model 2120/LX6	$339
NGC Complete List in Binder	$40
Casters (2" Diameter) for DS-16 (set of 3)	$33
Leveling Screws for DS-16 (set of 3)	$26
Leveling Screws for DS-10 (set of 3)	$20
#868 Extension Tube (2") (DS-10A, DS-16A)	$18.50
Setting Circles for DS-10: 3" Diameter w/pointer	$26
Setting Circles for DS-16: 6" Diameter w/pointer	$56
Vinyl Dust Cover for DS-16	$26
Vinyl Dust Cover for DS-10	$19.50
Lens Caps — 96, 1¼	$.50 EA (7 for $3)
Vinyl Dust Cover pair 6" (628C, 645C)	$26
Vinyl Dust Cover pair 8" (826C, 880), 10" (1060)	$36
Accessory Shelf for DS-10	$28
Accessory Shelf for 880, 1060, 1266	$36
Accessory Shelf for Field Tripod (2045, 2080, 2120)	$28
#AD-1 Eyepiece Adapter .965	$12
#AD-2 Eyepiece Adapter 1.25"	$16
#66A Manual Declination Control	$43
#66C Manual Declination Control	$57
1.30" M.A. Mirror	$28
1.52" M.A. Mirror	$35
1.83" M.A. Mirror	$38
2.14" M.A. Mirror	$42
Elliptical Secondary Mirror 2.60" (DS-10)	$48
3.10" M.A. Mirror	$80
Elliptical Secondary Mirror 4.00" (DS-16)	$109
6" f/8 Mirror	$119
6" f/6 Mirror	$135
8" f/6 Mirror	$185
10" f/6 Mirror	$395
12½" f/6 Mirror	$590
10" f/4.5 Mirror	$399
16" f/4.5 Mirror	$599
Mirror Cell for 6" Mirror (fits 7 1/16" I.D. Tubing)	$39
Mirror Cell for 8" Mirror (fits 9¼" I.D. Tubing)	$49
Mirror Cell for 10" Mirror (fits 12⅜" I.D. Tubing)	$89
Mirror Cell for 12½" Mirror (fits 15" I.D. Tubing)	$99
7⅜" O.D. x 30" Long Fiberlite Tube	$60
7⅜" O.D. x 50" Long Fiberlite Tube	$86
9½" O.D. x 50" Long Fiberlite Tube	$96
12¾" O.D. x 62" Fiberlite Tube Ship TFC	$150
15⅝" O.D. x 75" Fiberlite Tube Ship TFC	$210
End Rings for 7⅜" Tube pair	$19.50
End Rings for 9½" Tube pair	$26
End Rings for 12¾" & 15⅝" Tube pair	$36
Slide Set 1 or 2	$13

**TRADE-INS CONSIDERED
— SEND S.A.S.E. FOR USED LIST**

Pauli's Wholesale Optics d/b/a **WHOLESALE OPTICS**

29 Kingswood Road
Danbury, CT USA 06811
(203) 746-3579

FAX (203) 746-7572 (24 HRS.)

WHOLESALE **Buyers Guide** $3.00

Telescope-Accessory Cat. — Trade-ins considered —

Telescope-Accessory Catalogue/Data Pack (1 lb.) $3.00
Complete pkg. — Telescopes, Spotting Scopes, Accessories, Binoculars (2 lbs.) $5.00
Minimum Shipping Charge (via UPS) $4.00
Showroom Hours 10 a.m.-6 p.m., Mon. thru Sat.
Phone Orders 9 a.m.-9 p.m., Mon. thru Sat.

3% credit charge

Prudential-Bache Focuses On Space

At Prudential-Bache Securities, we're always looking for special opportunities for astute investors . . . unusual situations that may hold particular interest for you as an investor.

To learn more about how we view the future prospects for investing in securities of companies involved in the Space Industry, just call or write for more information and a free research report.

Mark A. Thompson
Associate Vice President-
Investments

6700 East Pacific Coast Highway
Long Beach, CA 90803
213-493-5581, 714-827-0813 or
800-523-4797

Prudential-Bache
Securities®
Rock Solid. Market Wise.®

SPECTRA SOURCE proudly introduces the
LYNXX CCD Imaging Systems

Four Image Processing Systems for CCD Imaging as low as $1099.

Full featured Research Grade CCD Imaging Systems that provide true photometric performance for the most exacting requirements. Their low cost places CCD image capture and processing within your reach for the first time. Enter a new Realm in Astronomy!

LYNXX **CCD Image. Six minute exposure of M31 taken with 135mm f/3.5 telephoto lens.**

- Research Quality & Performance
- Record & Enhance Images in Seconds
- NTSC Composite Video Output
- AutoGuide Capability
- 16th Mag. in <30 sec w/8" f/10 SCT
- Precise Magnitude Measurements
- Low Noise (30e), High Resolution
- 12 Bit A/D Converter
- Perform Blink Comparisons
- Zoom, Pan, and Invert Images
- Enhance Contrast, Sum Images
- Stand-Alone *and* PC-based Models
- Fast Data Transfer to Computers
- Exposures from 0.01 sec to >20 min
- Solid State TEC Cooled Camera
- Hi-speed Mechanical Shutter
- Four frames/second in Focus Mode

LYNXX PC CCD System	$1099
LYNXX PC Plus CCD System	$1399
LYNXX Stand Alone CCD	$2975
LYNXX Plus Stand Alone	$3750

World Wide distribution available. Send $5 for Demo Disk and Data Pac

SpectraSource Instruments P.O. Box 1045
Agoura Hills, CA 91376-1045 (818) 707 2655

NASA

BOLDLY GO WHERE NO VIDEO HAS GONE!

PLANET AND UNIVERSE — William Shattner takes you on a two-hour guided tour of Space: The Final Frontier

APOLLO — Apollo VIII, XI, XV and XVII (2 HRS)

GEMINI — Gemini IV, VI, VII, VIII and XII (2 HRS)

SPACE SHUTTLE — STS I thru VIII (2 HRS)

SPECIAL — BUY ALL FOUR, GET A FREE 1-YEAR SUBSCRIPTION TO ASTRONOMY!

ONLY $29.95 EACH!

Nolly Productions

CALL TOLL-FREE
1-800-437-0800

5145 S. LEWISTON WAY
AURORA, CO 80015

Get Ready for Comet Austin

Astronomers have high hopes that Comet Austin will put on a fine show in late April and May.

by Richard Talcott

When New Zealand amateur astronomer Rodney Austin discovered his third comet in early December 1989, no one thought it was anything special. But as reports came in over the next few days and astronomers computed the new comet's orbit, it quickly became apparent that Comet Austin could be the brightest comet to grace our skies since Comet West in 1976. And on top of that, Comet Austin would appear high in the sky for Northern Hemisphere observers.

The time is now at hand. After spending the first three months of 1990 hanging low in the western twilight sky after sunset, Comet Austin shoots up into the morning sky during the second half of April. The comet climbs higher with each passing day and is well-placed for viewing in the eastern sky before dawn. During May the comet fades slightly, from 2nd magnitude to 3rd magnitude if predictions are correct, but continues rising earlier so that by the last week of the month it is in the sky all night long.

The apparition of Comet Austin looks promising for both backyard observers and the public in general. Simply follow a few guidelines to get the best view of the comet. First, observe from a location as far removed from artificial lighting as possible. Although the comet should be bright enough to glimpse with the naked eye from many city locations, the view will be much better under a dark sky.

Second, your best views of Comet Austin will come when the Moon is out of the sky. The light from the Moon, particularly when it is more than half lit, washes out the comet's image as effectively as city lights. Fortunately there are two excellent observing "windows" — one in late April and the other in the last half of May — when the comet is bright and high in the sky and the Moon is out of the way.

Finally, you need to find an observing site that gives you a clear view toward the comet. This is particularly important during March and April when Austin hovers near the horizon. In March and the first half of April the comet is an evening object and you'll need a site with an unobstructed western horizon. In the latter part of April the comet rises ahead of the Sun and you'll need a site with a clear view to the northeast.

Naked-Eye vs. Optical Aid

If the comet brightens as predicted, you won't need any optical aid to get a good view of it. During the height of the apparition Comet Austin should be easy to see with the naked eye. In addition, the comet's tail could stretch several degrees across the sky, and a naked-eye view would then be the only way to see the whole comet.

But depending on what you're most interested in seeing, optical aid may give you a more satisfying view of Austin. A pair of binoculars will be particularly helpful early and late in the apparition when the comet is fainter, or if the comet doesn't brighten as much as expected.

Binoculars are also the instrument of choice for a detailed look at the comet's tail. A pair of 7x50s or 10x50s gives you a better view than birdwatchers' traditional 7x35s, but any quality pair will suffice. Sturdily mounted giant binoculars — 11x70s, 16x80s, or 20x80s — will provide the best view of the tail, but you may have to scan across several fields of view to see the whole thing.

To get a closeup look at the head, or coma, of Comet Austin, you'll need a telescope. Your best view will come in a 6-inch or larger telescope at medium to high magnifications.

How Bright Will It Get?

All other things being equal, the more gas and dust a comet gives off, the brighter it is. This intrinsic luminosity is governed by how close the comet is to the Sun, because the Sun's warmth causes the ices in the comet's nucleus to sublimate (turn directly into gas). The apparent brightness of the comet depends on its intrinsic brightness and how far away it is from Earth.

Unfortunately, determining how much gas and dust a given comet will release is a very tricky business. For that reason the predictions of Comet Austin's brightness should be viewed as estimates and not guarantees. The figures in this article are an average of astronomers' best predictions. However, no one would be surprised if the comet turns out to be a couple of magnitudes brighter or fainter than predicted.

Although astronomers may not be able to predict with certainty how bright Comet Austin will be, they can predict accurately where it will be in the sky. The altitudes and azimuths given in this article are for an observer located at 40° north latitude. (This approximates the view for observers in the United States, Canada, and Europe.) The view from other mid-northern latitudes is similar until late May and June when the comet is higher in the sky the farther south you are.

March: Low in the Evening

Comet Austin brightens rapidly during March but is difficult to see against the twilight background of the western evening sky. It travels almost due north this month, beginning in Cetus, moving through Pisces, and ending up in extreme western Aries. The comet should reach 6th magnitude, normally considered the limit of naked-eye visibility, after the first week of March. It brightens by about a magnitude each week after that. By the 31st Austin is expected to shine at about magnitude 2.5.

Unfortunately, Austin lies nearly in the same general direction as the Sun and sets only a short time after the Sun does. The comet remains between 6° and 7° above the horizon at the end of nautical twilight throughout March. (Nautical twilight ends when the Sun is 12° below the horizon, far enough that a casual observer would consider it dark even though scattered sunlight keeps the faintest naked-eye stars from being seen.) At the end of astronomical twilight — when the Sun is 18° below the horizon and the sky first becomes perfectly dark — Comet Austin is less than 1° high.

Your best chance of seeing Austin in March is at the end of the month when the Moon is out of the sky and the comet has brightened enough to see against the twilight glare. Start searching no later than 7:15 p.m. local standard time, which is the end of nautical twilight. With binoculars, scan the horizon slightly north of due west, looking for a diffuse patch of light. If you find the comet with binoculars, try viewing it without optical aid.

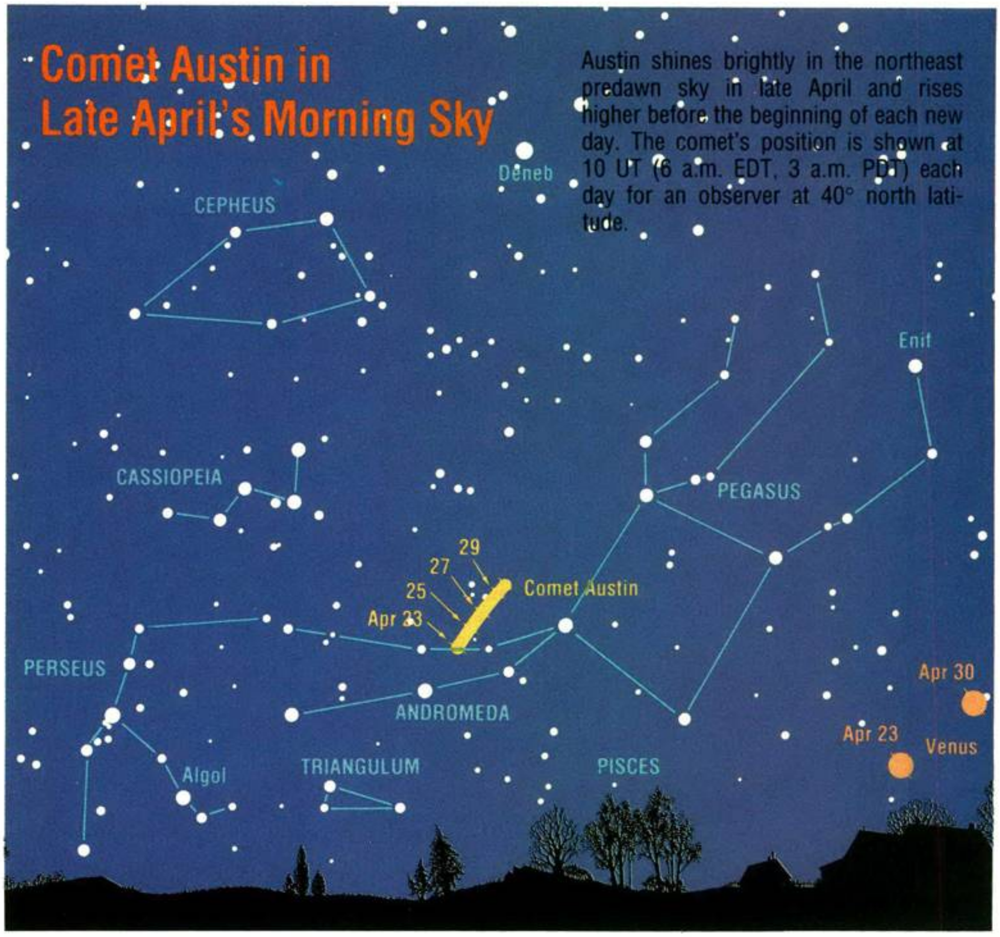
Early April: Mercury Lends a Hand

Prospects improve a bit in the first ten days of April. Although Austin slowly loses altitude, it continues to brighten and lies near the bright planet Mercury. By using Mercury as a guide, you should be able to spot the comet in binoculars.

On April 1 Comet Austin lies about 5° directly above Mercury in the west after sunset. The 2nd-magnitude comet pales in comparison to the –1.2-magnitude Mercury, but its proximity to the easily spotted planet makes it much easier to find.

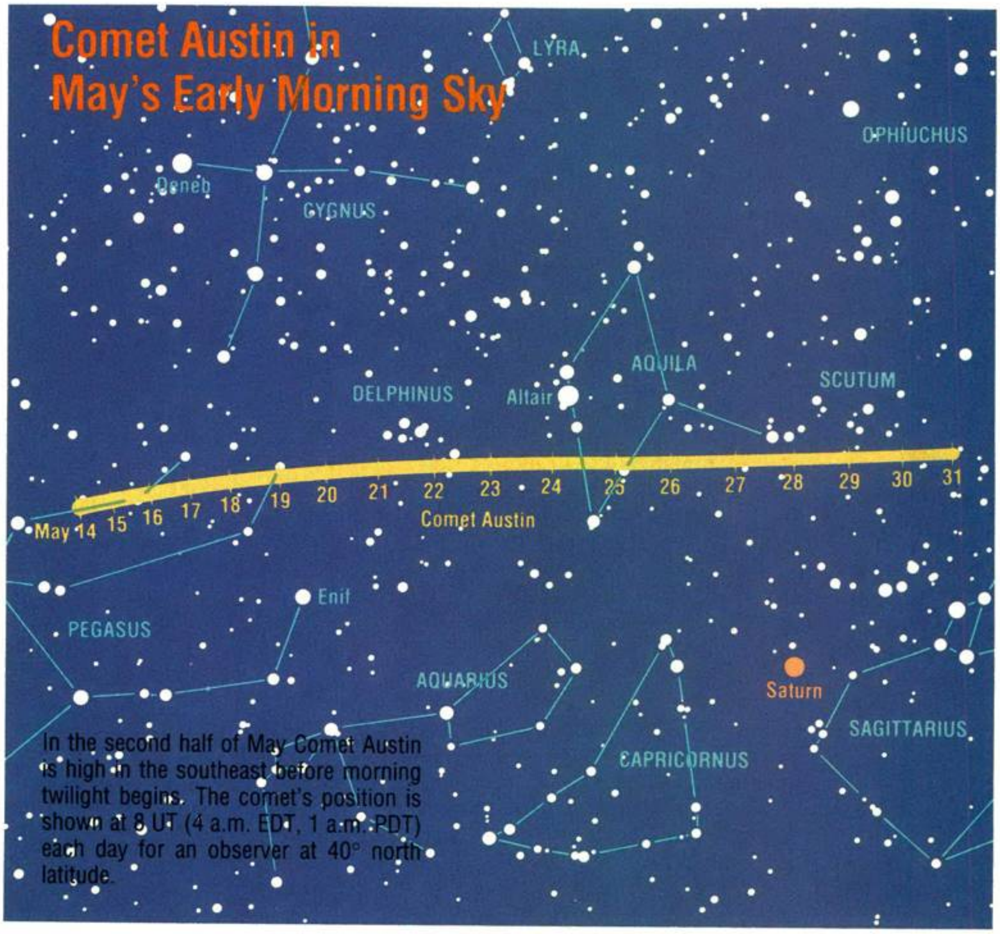
The two solar system objects remain near each other in early April. Mercury serves as a useful guide to Comet Austin once again on April 8. That evening the two have the same altitude in the evening sky (a bit over 5° at the end of nautical twilight) with the 1st-magnitude comet located about 13° to the right of the –0.5-magnitude planet.

That is probably your last reasonably good opportunity to see Comet Austin before it disappears into the Sun's glare. On April 9 the comet reaches perihelion, its closest approach to the Sun, and it is brightest two days after that. Unfortunately, Austin is only 4° high when twilight ends that night and the lower elevation hurts your chances more than the slightly greater brightness helps.



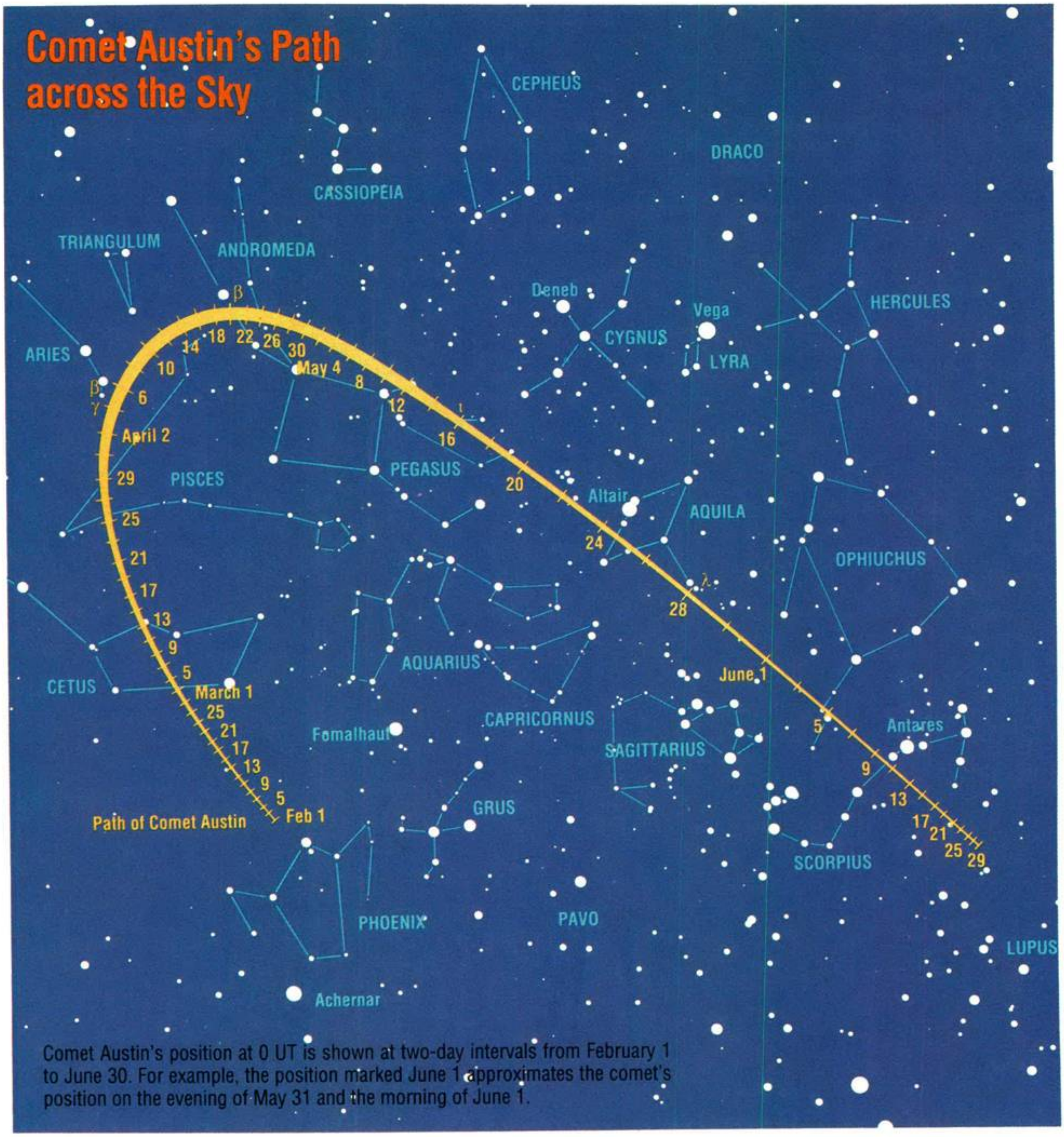
Comet Austin in Late April's Morning Sky

Austin shines brightly in the northeast predawn sky in late April and rises higher before the beginning of each new day. The comet's position is shown at 10 UT (6 a.m. EDT, 3 a.m. PDT) each day for an observer at 40° north latitude.



Comet Austin in May's Early Morning Sky

In the second half of May Comet Austin is high in the southeast before morning twilight begins. The comet's position is shown at 8 UT (4 a.m. EDT, 1 a.m. PDT) each day for an observer at 40° north latitude.


Comet Austin's Path across the Sky

CEPHEUS
CASSIOPEIA
DRACO
TRIANGULUM
ANDROMEDA
β
ARIES
β
γ
Deneb
Vega
CYGNUS
LYRA
HERCULES
PISCES
PEGASUS
Altair
AQUILA
OPHIUCHUS
λ
ι
CETUS
AQUARIUS
CAPRICORNUS
SAGITTARIUS
Antares
Fomalhaut
GRUS
SCORPIUS
PHOENIX
PAVO
LUPUS
Achernar
Path of Comet Austin
Feb 1
5
9
13
17
21
25
March 1
5
9
13
17
21
25
29
April 2
6
10
14
18
22
26
30
May 4
8
12
16
20
24
28
June 1
5
9
13
17
21
25
29

Comet Austin's position at 0 UT is shown at two-day intervals from February 1 to June 30. For example, the position marked June 1 approximates the comet's position on the evening of May 31 and the morning of June 1.

Late April: First Good View

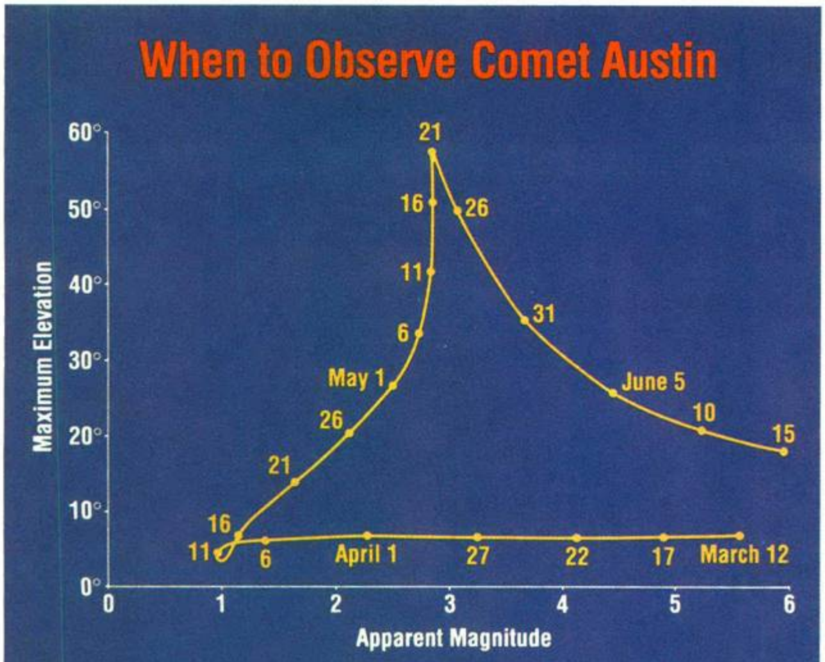
Prospects for seeing Austin improve dramatically during the last ten days of April. After passing closest to the Sun, the comet rapidly moves into the morning sky where it gains altitude with each passing morning. The waning crescent Moon is in the sky from April 19 to 24, but as it moves closer to the comet it also grows dimmer and thus won't be a major problem. The Moon is completely gone from the morning sky from April 25 through the end of the month.

During this first good observing window Comet Austin moves progressively higher in the morning sky and fades only slightly, to 2nd magnitude. In the predawn sky of April 19 the comet lies 6° above the northeastern horizon at the beginning of astronomical twilight and climbs to 11° above the horizon at the onset of nautical twilight. The 2nd-magnitude star Beta (β) Andromedae lies just 1.5° northeast of Comet Austin that morning.

But the most exciting conjunction of late April is the comet's passage near the Great Andromeda Galaxy (M31). The two lie about 5° apart on the morning of April 24, but you should start watching the pair as early as the 19th. The geometry of the Sun, Earth, and comet causes Austin's ion tail to point right at the galaxy on the mornings of April 19, 20, and 21. Although no one knows for sure if the tail will be long enough to stretch in front of the galaxy, the geometry around that time is favorable. The tail could easily exceed 10° in length, which would be more than enough to reach M31.

During the late April observing window the comet's tail will be pointing nearly straight up from the horizon, so it should come into view well before the comet's head. Begin looking for the tail around 3:30 a.m. local daylight time on the 19th, about thirty minutes before the head of the comet rises. Once again binoculars will help you spot it, but you should be able to see it with the naked eye.

As the month progresses the comet rises earlier and is higher in the sky when twilight begins. On the



Comet Austin is easiest to see when it is bright (toward the left in this diagram) and high in the sky (toward the top). The maximum elevation is for an observer at 40° north latitude when the sky is at least as dark as it is at nautical twilight.

Week of	Mag.	Phase	Time	Alt.	Dir.	Notes
March 25	3rd	New	Evening	7°	W	Twilight interferes
April 1	2nd	First	Evening	6°	WNW	Mercury nearby
April 8	1st	Full	Evening	4°	NW	Brightest, but near Sun
April 15	1st	Last	Morning	11°	NE	Improves rapidly
April 22	2nd	New	Morning	19°	NE	Excellent; south of M31
April 29	3rd	First	Morning	28°	ENE	Good early in week
May 6	3rd	Full	Morning	38°	ENE	Moon hurts visibility
May 13	3rd	Last	Morning	51°	E	Better late in week
May 20	3rd	New	Morning	56°	SSE	Excellent
May 27	4th	First	Early morn.	38°	S	Good after midnight
June 3	5th	Full	Midnight	24°	S	Moon overwhelms comet
June 10	6th	Last	Late eve.	19°	S	Better late in week

Mag.: Estimated apparent magnitude. **Phase:** Phase of the Moon. **Time:** The time when Austin is best-placed for observing (morning means start of morning twilight, evening means end of evening twilight). **Alt. and Dir.:** The comet's altitude and direction in the sky for an observer at 40° north latitude at the best time to look.

morning of the 25th Austin rises around 3:00 a.m. local daylight time and stands 19° above the northeastern horizon when nautical twilight begins. By the 30th the comet rises around 2:00 a.m. local daylight time and is 25° above the horizon at the onset of nautical twilight.

May: Austin at Its Highest

Although the Moon returns to the morning sky in early May, it sets before morning twilight begins until May 6. During these few days Austin should be easy to see above the Great Square of Pegasus for an hour or two before twilight begins.

As the Full Moon of May 9 approaches, however, the visibility of the comet deteriorates. As bright moonlight fills the sky the diffuse glow of the comet will be hard to see, though with some effort and a pair of binoculars you may be able to pick it out.

The last half of May brings with it the second good observing window for Comet Austin. Although the comet is now receding quickly from the Sun, it continues to approach Earth until May 25. Because it keeps coming closer to Earth, Austin does not fade much and should remain brighter than 3rd magnitude until the 25th. Throughout this period the comet is high in the sky and rises earlier each day, so it should remain easy to see.

On May 15 Austin rises around 11:45 p.m. local daylight time and is 41° high in the east by the time astronomical twilight begins. On the 21st it rises around 11:00 p.m. and is more than 50° high at the beginning of twilight. And on the 31st Austin rises around 9:30 p.m., before the end of evening twilight, and is highest in the south around 3:00 a.m.

The comet moves rapidly during the last half of May, passing through Pegasus, Delphinus, Aquila, and Scutum, and finally into extreme northern Sagittarius by month's end. It passes 1° from the 4th-magnitude star Iota (ι) Pegasi on the 16th, 7° south of the 1st-magnitude star Altair on the 25th, and about 2° south of 3rd-magnitude Lambda (λ) Aquilae on the 28th. But the most interesting conjunction in May occurs on the night of May 30/31 when Austin passes in front of the Omega Nebula (M17) in northern Sagittarius.

In mid-May Austin's tail points toward the west and should be near its greatest extent. After that the tail geometry worsens. By the 31st the tail points nearly away from us; it will look short even if it is physically long in space.

June: Fading Rapidly

By the start of June Comet Austin is moving away from both the Sun and Earth. This causes Austin to fade rapidly during the month, from about 4th to 8th magnitude. The Moon is Full on the 8th, so the comet can be seen early in the morning for the first few days of June and then in the evening sky after about June 12.

Despite growing dimmer, the comet should be quite easy to see in binoculars from a dark-sky site. It is at opposition on June 7 when it rises at sunset, is high in the south around 1 a.m. daylight time, and sets at sunrise. It is visible all night long during the first half of the month and then moves into the evening sky.

Austin starts June in Sagittarius, then moves southwest through Ophiuchus and Scorpius, and ends the month in Lupus. The two most interesting conjunctions of the month are on June 1/2 when the comet lies about 1° south of the open star cluster M23, and on June 11/12 when Austin lies less than 5° south of the 1st-magnitude star Antares in Scorpius.

As June comes to an end most of the excitement will have died down. With the comet faint and its tail pointing nearly away from Earth, it will be far from spectacular. But if Austin lives up to its billing in April and May that won't matter. "The Great Comet of 1990" will have given us plenty of memories to reminisce about in future years. ☐

EXTRAORDINARY
PERSONAL SERVICE
from
Spectra™
Astro * Systems

Call For FREE 1990 Catalog
Filled with unique astro items!
(818) 343-1352 • 9 to 5 M-F P.S.T.
No Shipping charge in USA

Introducing an Innovative Spectra Exclusive
PulsGuide™ A pulsing power supply for reticle guiding eyepieces

Features fully adjustable on and off cycles or set it to stay on! Also, set illumination from soft glow through bright. Pulsing the reticle illumination lets your eye rest between pulses. This increases contrast of dim guide stars and reduces fatigue! You will guide better and longer. PulsGuide is:
- Compact & self-contained, with full control at your fingertips.
- Spectrally-pure red LED protects night-vision.
- Rugged & reliable with machined aluminum case & solid-state circuitry.
- Energy efficient - up to 70 hours from one 3-volt Lithium battery (included for limited time only)

PulsGuide (Specify type of reticle guiding eyepiece. Does the power supply thread in, or insert and lock with a thumbscrew?) **$59.95**
SPECIAL OFFER: PulsGuide with a 12mm illuminated reticle eyepiece (as shown) ... **$139.95**

FieldFinder See-Thru Grids
Place this durable weather-proof grid over your star chart and quickly see exact visual and 35mm phot fields. Also shows TelRad, 7x50 and 11x80 binocular views, and telephoto and telescopic fields from widefield through 2000mm focal length! Locate a guide star. Compose photos. Computer plotted and laser accurate. For use with sky charts:
- **Tirion Deluxe Color Book Model #1 • Tirion Desk or Field Edition Model #2**
- **Uranometria Books Model #3** .... **$8.95 each**

We Proudly Introduce the Latest in Pulse Technology
PulsVIEW™ with TelRAD®

PulsVIEW provides for easy location of low-magnitude stars with fully adjustable on and off cycle times and full illumination control. Pulsing and illuminated reticle lets your eye rest between pulses and improves contrast between the reticle and faint stars. Greatly increases the number of stars you can spot clearly through a TelRAD. Identify the star field and center up the object faster with PulsVIEW!

Install Your Own Kit: factory wired and tested with comprehensive instructions and one year warrantee **$32.95**
Complete Unit: New TelRAD with PulsVIEW mounted, wired & tested **$74.95**

Starlite™
by SPECTRA SYSTEMS

Large 3.5" Face

Astronomer's Timekeeper
This is the best way to keep track of exposures and to time events. Multi-featured: Counts up and down; Visual and audible signal when time is up; Auto Reset; 12 and 24 hour clock. Use large controls with gloves on! **$23.95**

Starlite Red LED Flashlight
It switches on to a soft red glow and can be adjusted precisely to the illumination you need. Spectrally-pure red light protects night vision. Starlite features a rugged case and solid-state circuitry with a 100,000+ hour LED and stable performance regardless of battery aging. Energy efficient. Get up to 625 hours with one 9-volt battery! **$24.95**

MasterCard VISA

6631 WILBUR AVE., SUITE 30-D
RESEDA, CALIFORNIA 91335

IF YOU ARE MOVING . . .

. . . please notify us five weeks prior to your move. Thank you.

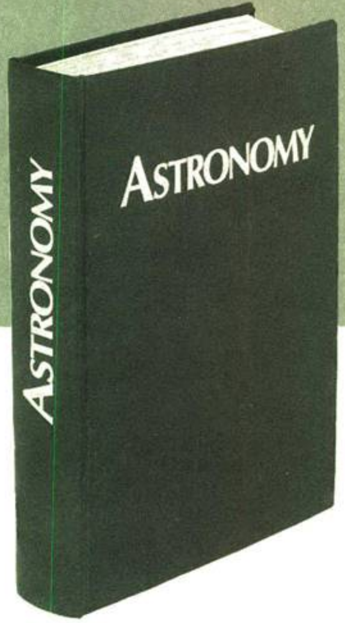
ATTACH MAGAZINE MAILING LABEL HERE, OR PRINT YOUR PRESENT ADDRESS BELOW.

PRINT YOUR NEW ADDRESS HERE

Name ______________________________
Street ______________________________
City, State, Zip ______________________________

MAIL TO: KALMBACH PUBLISHING CO., P.O. BOX 1612, WAUKESHA, WI 53187 **A**

ASTRONOMY'S
1989
BOUND VOLUME 17



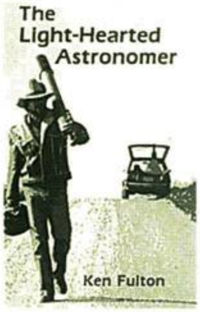
Now you can have 12 superb issues of fascinating articles, colorful and accurate star charts, and the latest exciting breakthroughs in astronomy at your fingertips with **ASTRONOMY Bound Volume 17**! Included are all of ASTRONOMY's 1989 issues (January through December), protected between hard covers in a high-quality blue binding. Supplies are limited – order your copy today!
$34.95 ($44.95 outside the U.S.) #44017

To order direct, use the Kalmbach order form bound in this magazine, or send to Kalmbach Publishing Co., P.O. Box 1612, Waukesha, WI 53187-1612. Include for postage and handling: U.S. $1.50; Canada and foreign add 15%. Wisconsin residents add 5% sales tax.

THIRD BIG PRINTING!

"Amateur Astronomers – A Strange Breed"

The Light-Hearted Astronomer



A Survival Manual for Amateur Astronomers

$7.95

#18001

128 pages, paperback, 5 1/2" x 8 1/2"

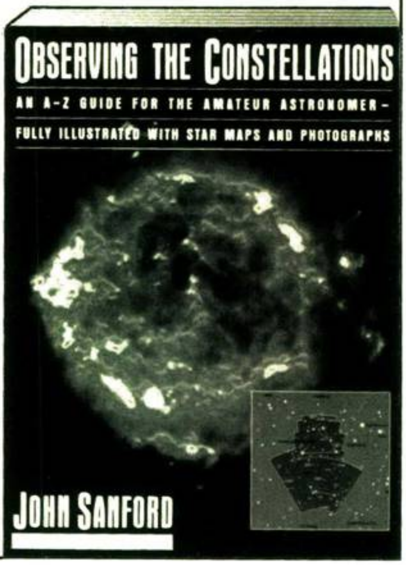
Written by Ken Fulton, a frequent contributor to ASTRONOMY, The Light-Hearted Astronomer presents chapters on such lively topics as: Amateur Astronomers – A Strange Breed; The Ads; The Telescopes; What Accessories Do You Really need?; Seeing What You Observe; Observing What You See; Living With a Non-Astronomer Spouse; Is the Universe a Harsh Mistress? In his distinctive and humorous style, Fulton tackles these subjects and many more! This informative book offers something never before published: "a survival manual" for amateur astronomers that tells it like it really is! Order your copy today!

To order, use the ASTRONOMY order form bound into this magazine, or send to ASTRONOMY Order Dept., 21027 Crossroads Circle, P.O. Box 1612, WI 53187-1612. Include for postage and handling: U. S. $1.50; Canada and foreign add 15 % (minimum $3). Wisconsin residents add 5% sales tax.

Comprehensive, colorful, easy-to-use – ideal for exploring the night sky.

Truly a star compendium from A to Z (88 constellations in alphabetical sequence), this volume documents each constellation beautifully, with *both* a full-color photograph by John Sanford and a detailed star map by Wil Tirion, the world's leading astrocartographer. With background information on each constellation, detailed tables and additional photos of exotic galaxies, nebulae and star clusters, OBSERVING THE CONSTELLATIONS is perfect for both casual and serious stargazers alike.

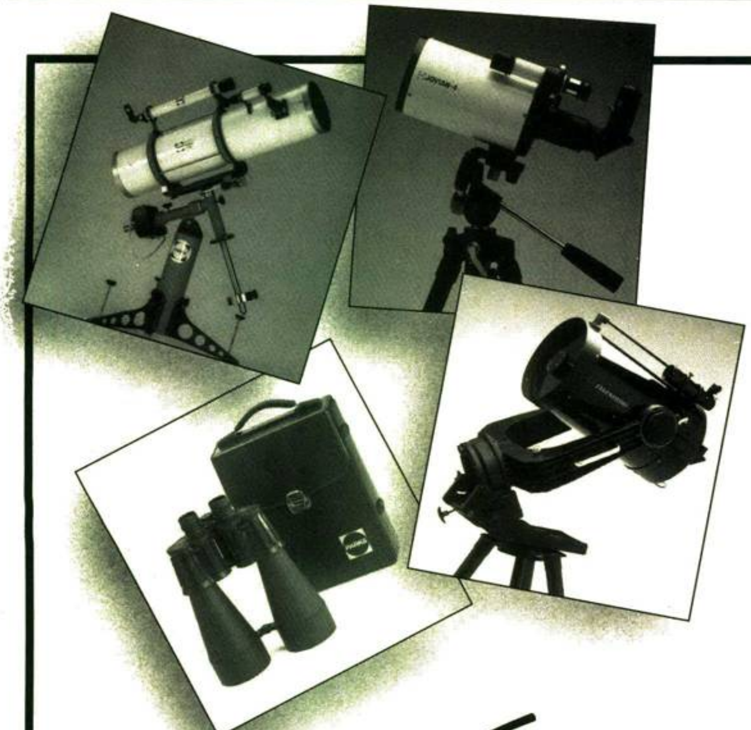
A Main Selection of the Macmillan Astronomy Book Club


OBSERVING THE CONSTELLATIONS
AN A-Z GUIDE FOR THE AMATEUR ASTRONOMER -
FULLY ILLUSTRATED WITH STAR MAPS AND PHOTOGRAPHS
JOHN SANFORD

F FIRESIDE BOOKS

SIMON & SCHUSTER INC.
A PARAMOUNT COMMUNICATIONS COMPANY

Cover design: Sue Keston
Cover photo: NRAD/AVI/Science Photo Library, London
Star Map: Wil Tirion



Tired of just looking at pictures?

Then come to Scope City and see first-hand what you've been missing.

Scope City, the world's largest and most complete telescope and binocular discount centers, offers you telescopes for **astronomy, sports, land/sea, view-homes,** and **photography**, as well as a huge selection of binoculars at discount prices.

On the other hand, if you're unable to visit us, we'll send you our catalog . . . *Yes, it has more pictures.*

Scope City/Mail Order Dept.
P. O. Box 440
Simi Valley, CA 93065
Info. & ordering in CA (805) 522-6646
National Toll Free (800) 235-3344

Scope City

TELESCOPES • BINOCULARS • SPORT OPTICS

BUY • SELL • TRADE • SERVICE

SIMI VALLEY, CA
679 Easy St.
(805) 522-6646

TORRANCE, CA
3132 Pac. Coast Hwy
(213) 326-3251

COSTA MESA, CA
3033 S. Bristol
(714) 957-6900

LAS VEGAS, NV
2216 Paradise Rd.
(702) 733-9288

SAN DIEGO, CA
4766 Clairemont
Mesa Blvd.
(619) 277-6686

SURPLUS STORE
Simi Valley, CA
679 Easy St.
(805) 522-6646

Authorized Meade Dealer

Meade

PREMIER SERIES

» Meade's new ***Premier Series*** is the most comprehensive "system" of fork-mounted Schmidt-Cassegrain astronomical telescopes and accessories available.

» All of the various ***Premier Series*** models start out with Meade's famous "LX6" digital-electronic DriveBase assembly.

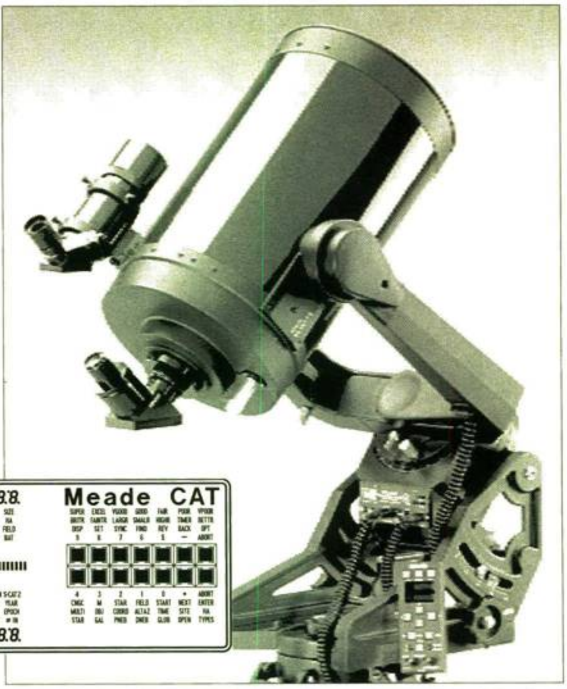
» Then, you may choose from one of four different telescope tube assemblies: 8 or 10-inch aperture, f/10 or f/6.3 focal ratio.

» Finally, there are four different levels of "accessorization" available - all the way from bare-bones to the fully-loaded, top-of-the-line version (which includes such amenities as four premium-grade eyepieces, Digital Readout System, Computer-Aided Telescope System, Astrophotography Accessories Package, etc.).

» In all, there are sixteen different models to choose from.

» We're in our seventh year of helping amateur astronomers, worldwide, choose the telescopes and accessories that best suit their needs and budgets, and the report card on our honesty, integrity, knowledge, experience and service to our customers is consistently "Excellent!".

» Write or call for assistance, information, details, and pricing.



OUR GUARANTEE: We are solely, exclusively, professionally, a first-line, quality telescope dealership. We guarantee, unconditionally, that when you purchase a telescope or other item from us, you will receive all of the equipment and accessories that its manufacturer specifies for it. ***We do not*** "strip" scope kits, ***nor do we*** charge extra for the equipment, accessories or warranties intended by the manufacturers to be included with their equipment. When you buy from us, you will receive everything you pay for - you can count on it. We further guarantee, unconditionally, that all equipment sold by us is brand-new and factory-fresh. ***We do not*** take unscrupulous advantage of distant and helpless mailorder buyers; ***we do not*** buy and ***we do not*** sell ***RETURNED***, reconditioned, rebuilt, demonstrator, floor-sample, shopworn, used, loaner, rental, prototype, cosmetic defect, factory-second or otherwise imperfect goods. Don't let yourself be fooled - buy only from a knowledgeable, reputable, dealer.

california telescope company

CA & AK, or for INFORMATION, CALL (818) 505-8424. Interbank wire transfers, DiscoverCard, MasterCard & Visa accepted - no surcharge. Most items free UPS Ground shipping in the contiguous 48 states. California shipping addresses add sales tax. Send business-sized **SASE** for ***Free Discount Price List***; $5 ($8 foreign) check or MO for Catalog Package. RFQ's welcome. All prices and specifications are subject to change without notice or obligation. Astronomy AS90-02MA

Export Sales, Government, Institutional & Commercial Accounts WELCOME. For info, call:
(818) 505-8424
24 Hr. FAX: (818) 980-9331

P.O. Box 1338, Burbank, California 91507
TOLL-FREE, *ORDERS ONLY*, 10-4 Pacific Time, Mon-Fri:
(800) 843-4780 (U.S. except CA & AK)
For INFO, or from CA or AK, call: **(818) 505-8424**

Parks Jovian-4

The included camera adapter allows the Jovian-4 to be used as a 1000mm telephoto lens with the addition of an optional T-ring for your specific camera.

PARKS
JOVIAN-4

"May well be the very best quality telescope on the market for your money today."

PARKS OPTICAL
270 Easy St.
Simi Valley, CA 93065
Ordering & info.
(805) 522-6722

FREE COLOR CATALOG, (foreign USD $5). Parks Optical is not open to the public. Merchandise available through mail order or at any authorized Parks dealer worldwide. Quality Newtonians, refractors, and Schmidt-Cassegrain telescopes, binoculars, riflescopes, and accessories.

The unique combination of the Parks diffraction-limited "multi-coated" optics, the superior internal baffling system, an unusually small secondary obstruction, and the new ultra fine knob-type focus mechanism provides contrast and resolution previously thought to be unattainable with a small Cassegrain telescope. Under optimum sky conditions you can see 12th to 13th magnitude objects. See nebulae, galaxies, and star clusters, as well as detail on the moon and the planets. Images are crisp and clean to the edge of the field. With the addition of an erecting prism, the Parks Jovian-4 makes an enjoyable spotting scope for nature study, bird watching, hiking, and land/sea observing. Mounts on any standard photo tripod. Includes: 4" *optical tube assembly, 25mm 1¼" Gold Series eyepiece*, diagonal prism, 5x24 finderscope, photo-tripod adapter, lens cover, custom reinforced carrying case with shoulder strap and instruction manual. Lifetime warranty.

Jovian-4 . . . $1200.00 Shipping/handling $13. Cal. res. add 6¼% tax.

BRIGHT COMETS ABOUND IN THE WINTER SKY

As the 1980s passed into history, backyard observers could take their pick of several bright comets. During the final two weeks of the decade 3rd-magnitude Comet Aarseth-Brewington ($1989a_1$) was visible briefly in the morning sky before sunrise. The comet moved rapidly into the southern sky and faded to 6th-magnitude by the third week of January.

Comet Okazaki-Levy-Rudenko (1989r) peaked in brightness at 6th magnitude in late November before turning southward in a giant arc that carried it past the south celestial pole by December 25. Comet Helin-Roman-Alu (1989v) was visible in late November as a 10th-magnitude fuzzball, and Comet Skorichenko-George ($1989e_1$) was a 10th-magnitude object that was slowly brightening as the New Year began.

In late November and early December most of the attention centered on Comet Okazaki-Levy-Rudenko. "On the morning of Thanksgiving I was fortunate enough to see a beautiful conjunction between the Moon and Comet Okazaki-Levy-Rudenko," said George W. Gliba of Greenbelt, Maryland. "They were only about a degree apart and were framed nicely in my 8x50 binoculars. Seeing the crescent Moon alongside this fuzzy comet was a sublime spectacle of nature I had never before witnessed. The comet glowed at about 6th magnitude and had about the same surface brightness as the earthshine from the Moon."

During the last days of November attention began to shift to the brightening Comet Aarseth-Brewington. "On the morning of the 30th," said Gliba, "I observed Comet Okazaki-Levy-Rudenko and Comet Aarseth-Brewington in the same predawn sky. The two comets were both bright, glowing at 6th and 7th magnitudes respectively. I could see a 20'-long tail on the first comet, but none on Aarseth-Brewington."

By late December, however, Aarseth-Brewington proved itself one of the best comets of the decade. "On December 22 the comet shone at about 3.5 magnitude," said Gliba. "The comet hung low in the twilight sky. A few mornings earlier the comet shone at about 4th magnitude but was higher in the sky. It had a beautiful, curved dust tail that measured 3° long. The comet looked like a miniature Comet West, the last great comet I've seen. I thought that Aarseth-

COMET AARSETH-BREWINGTON captured the attention of observers as it brightened to 3rd magnitude at the end of 1989. Photo by Michael Stecker.

A MULTIPLE-COMPONENT TAIL characterized Aarseth-Brewington's appearance during the final weeks of December 1989. Photo by Howard J. Brewington.

COMET OKAZAKI-LEVY-RUDENKO faded to 9th magnitude by year's end, but it still presented a visible tail in binoculars. Photo by Paul Roques.

CAPTURING THE ALASKAN AURORA

The Northern Lights are spectacular from Alaska. This month's $100 "Best Astrophoto" award winner is John W. Warden's photograph of sheets of green aurora suspended in front of the Big Dipper, photographed from outside of Anchorage. Warden used a stationary camera mounted on a tripod.

The Sun's violent magnetic activity triggers this sort of magnificent auroral display. John Hicks captured a huge solar prominence on October 25, 1989 (bottom right), as he monitored the Sun with a hydrogen-alpha viewer. Three weeks later Floridian David M. Brewer captured on videotape another marvel of the solar system, the lunar crater Copernicus (opposite, bottom left). Gregory Terrance's photograph of Jupiter on November 22, 1989, shows that the planet's South Equatorial Belt was still invisible (opposite, bottom right). This feature's disappearance is one of the most unusual recent phenomena associated with Jupiter.

The fine, spidery tendrils of the Crab Nebula represent both the subtle beauty and the violence of the distant universe. Jack Newton photographed the Crab with his 25-inch f/5 reflector and a 30-minute exposure (below). Sculptor's NGC 55 is a galaxy rarely observed by amateurs due to its ghostly low surface brightness. Steve Quirk photographed the galaxy with a 10-inch f/5 reflector, hypered Ektar 1000 film, and a 20-minute exposure (bottom).

Brewington was certainly the best comet since Halley, and I've seen ten comets since that time."

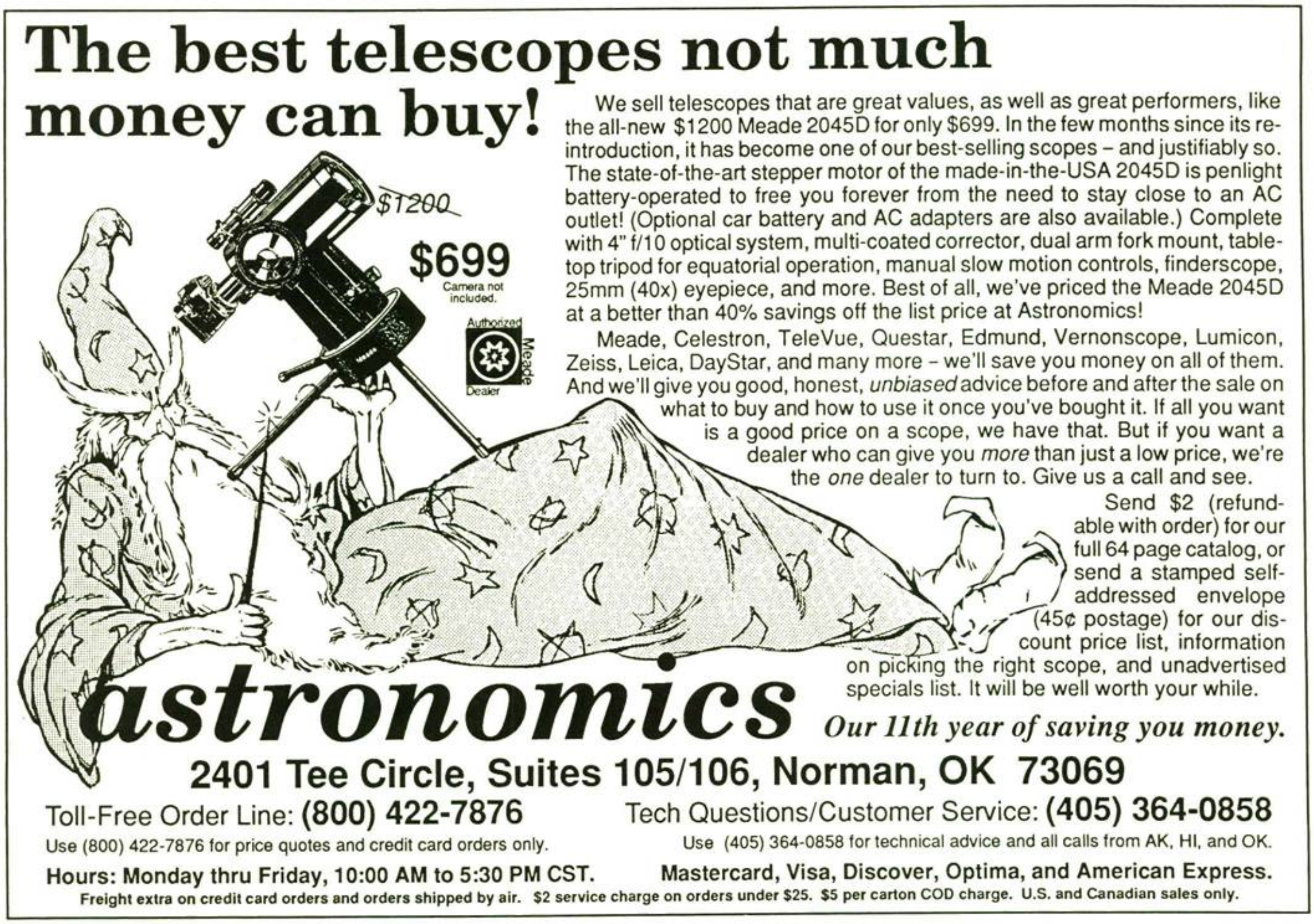
WINTER METEORS DELIGHT OBSERVERS

Although Northern Hemisphere observers had to brave some severely cold temperatures this year to get out under the stars, they turned out to watch winter meteors with great enthusiasm. During the final week of October George W. Gliba of Greenbelt, Maryland, recorded his observations of the Orionid meteor shower. "Overall I saw 66 meteors during six hours of observing," said Gliba. "I observed during two-hour windows on October 22, 23, and 24, 1989.

"The Orionids are rather fast meteors, with an average magnitude of 3. They are typically blue-white in color. About one in three left a visible train. Although the average meteor was rather faint, three Orionids reached –1 magnitude and glowed with a beautiful yellow-orange color."

Michael Boschat of Halifax, Nova Scotia, did not let poor weather inter-

A GEMINID FIREBALL flashes over the dome of a backyard observatory near Topeka, Kansas. Photo by Rick Schmidt.


~~$1200~~
$699
Camera not included.
Authorized Meade Dealer

The best telescopes not much money can buy!

We sell telescopes that are great values, as well as great performers, like the all-new $1200 Meade 2045D for only $699. In the few months since its reintroduction, it has become one of our best-selling scopes – and justifiably so. The state-of-the-art stepper motor of the made-in-the-USA 2045D is penlight battery-operated to free you forever from the need to stay close to an AC outlet! (Optional car battery and AC adapters are also available.) Complete with 4" f/10 optical system, multi-coated corrector, dual arm fork mount, tabletop tripod for equatorial operation, manual slow motion controls, finderscope, 25mm (40x) eyepiece, and more. Best of all, we've priced the Meade 2045D at a better than 40% savings off the list price at Astronomics!

Meade, Celestron, TeleVue, Questar, Edmund, Vernonscope, Lumicon, Zeiss, Leica, DayStar, and many more - we'll save you money on all of them. And we'll give you good, honest, *unbiased* advice before and after the sale on what to buy and how to use it once you've bought it. If all you want is a good price on a scope, we have that. But if you want a dealer who can give you *more* than just a low price, we're the *one* dealer to turn to. Give us a call and see.

Send $2 (refundable with order) for our full 64 page catalog, or send a stamped self-addressed envelope (45¢ postage) for our discount price list, information on picking the right scope, and unadvertised specials list. It will be well worth your while.

astronomics *Our 11th year of saving you money.*

2401 Tee Circle, Suites 105/106, Norman, OK 73069

Toll-Free Order Line: **(800) 422-7876**
Use (800) 422-7876 for price quotes and credit card orders only.

Tech Questions/Customer Service: **(405) 364-0858**
Use (405) 364-0858 for technical advice and all calls from AK, HI, and OK.

Hours: Monday thru Friday, 10:00 AM to 5:30 PM CST. **Mastercard, Visa, Discover, Optima, and American Express.**

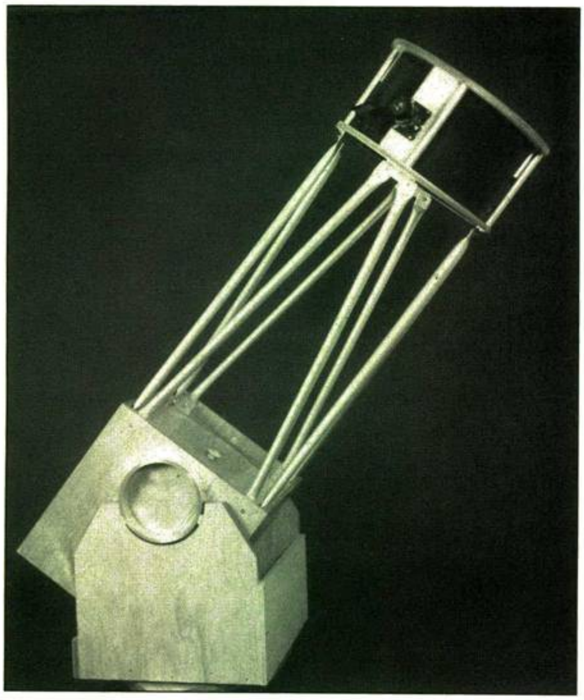
Freight extra on credit card orders and orders shipped by air. $2 service charge on orders under $25. $5 per carton COD charge. U.S. and Canadian sales only.

A STREAK AGAINST THE SKY, this faint, fast-moving meteor typifies the Geminid shower. Photo by Jiri Krakora.

fere with his meteor observing. "The maximum of the Orionid shower was clouded out in Nova Scotia, but I monitored the meteors using a radio," reported Boschat. "On October 21 I counted between 12 and 32 meteors per hour, none lasting more than half a second. The average hourly rate was 22 meteors. There was occasional aircraft flutter, but this did not interrupt the observing run."

Although November's Leonid meteor shower is normally rather quiet, Gliba observed it. "I was surprised by the high rate of activity," said Gliba. "On November 17 I saw 10 Leonids in 40 minutes before twilight started to interfere, 8 during the first half hour."

The night of maximum for the Geminid meteor shower came on December 13. "Despite the nearly Full Moon," Gliba reported, "I went out anyway. The brightest meteors were easily visible. Of the 45 I saw, 3 reached –1 magnitude, 1 reached 0 magnitude, and 16 attained 1st magnitude. Despite the Moon and the cold, it was a shower that was definitely worth seeing." — *David J. Eicher*



VERY PORTABLE TELESCOPE

- Experts agree that when observing deep sky objects there is no substitute for aperture
- Each telescope hand built
  Each optic hand figured
- Stable • Lightweight • Portable
- 20," 18," 14.5,"
  for the photon hungry!
- Advanced Digital Setting Circles
- FAST set up, easy to use

Sky Designs

1-800-833-1179 • US & CANADA

4100 FELPS, SUITE C
COLLEYVILLE, TEXAS 76034

OXYMORONIC ASTRONOMY

The vocabulary of astronomy is full of words and phrases that baffle newcomers. Who doesn't remember puzzling at first over what *stellar magnitude* means, when the merest look at the sky tells you that stars don't have sizes? (And to make things worse, the scale runs backwards, with dimmer stars getting bigger numbers, but that's another matter.) Or what about *redshift?* Now there's a word whose meaning isn't exactly transparent.

Once you spend some time in amateur astronomy, though, words like these become second nature. You understand them, you use them with friends, and they seem as familiar as a favorite eyepiece. But therein lies a danger. It's all too easy to lose touch with the root meanings of those specialized words that you're completely comfortable with.

What makes it worse is that a lot of astronomical phenomena are named long before anybody understands what's really going on. That's why we still have abominations like *planetary nebula,* which is actually a cloud of gas thrown off by an aging star. The term persists, however, despite the fact that for more than a century astronomers have known that these objects have nothing whatever to do with planets.

Some of astronomy's worst words are oxymorons — self-contradicting terms. (Oxymoron is derived from Greek: *oxy-* means sharp and *-moron* means dull.) No doubt you've encountered such oxymorons as *jumbo shrimp, military intelligence,* and *postal service.* Our own beloved astronomy is also rife with these self-canceling phrases.

All I ask is that you stop and think a moment before rushing to use such blatant offenders as...

Waning Crescent

Sounds innocuous, doesn't it? But *crescent* comes from the same Latin root as the musical term *crescendo* and it means growing. A crescent phase therefore is a growing phase — which makes sense when you apply *crescent* to the sunlit portion of the Moon just after New. (On the other hand, to call it a *waxing* crescent is to commit a redundancy, but never mind.) However, astronomy also applies the term *crescent* to the phases after Last Quarter, when the illuminated Moon is growing steadily thinner.

The Solar Constant

Astronomers have been carefully measuring the intensity of sunlight for several decades. Corrected for effects of atmospheric absorption and Earth's varying distance from the Sun, this intensity of radiation is called *the solar constant.* Yet in recent years astronomers have found that the Sun's output varies slightly. It must not be a large variation, however, or else why would you hear astronomers unblinkingly describe how the solar constant changes?

Nova

For centuries skywatchers have reported the sudden appearance of "new" stars, the Latin for which is *nova stella,* shortened nowadays to *nova.* New stars? Hardly. For a long time now, astronomers have understood that such outbursts invariably come from old, dying stars, not new ones.

Novae occur in well-aged binary star systems, where a degenerate white dwarf draws material from a giant companion star. At long intervals, the transferred material abruptly explodes, brightening the star system several thousand-fold. As seen from Earth, the result is called a nova even though astronomers know these events happen when the stars involved are entering old age.

Well, then, what about *supernova?* No go here, either, because it amounts to much the same thing. A supernova is a massive star at the end of its life that goes bang in an effort to get rid of excess material. A supernova may be thousands of times brighter than a nova (and hundreds of times more rare), but it's still nothing new.

Forbidden Lines

Much of astronomy's evidence for the chemical and physical nature of stars and nebulae comes from spectroscopy. Astronomers break up starlight into its rainbow spectrum of colors and note which colors are missing (absorption lines) or which are extra-abundant (emission lines).

Each spectral line results from a specific chemical under specific conditions. But scientists on Earth can't produce certain spectral lines in laboratories because they can't replicate precisely all the conditions found in outer space. When astronomers found celes-

ODYSSEY
TELESCOPES
Seeing the *real* Universe

FREE INFORMATION
- ODYSSEY GUIDE
- OWNER COMMENTS
- REPRINTS
- DOBSONIAN INFO.
- COULTER OPTICAL NEWS
- PRODUCT LIST

ASK FOR IT!

8 inch $239.50

"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

10.1 inch $299.50

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

13.1 inch $499.50

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!"
Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

17.5 inch $995.00

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

Lightweight Mirror Optics at Low, Low Prices:
Pyrex, ⅛ wave, aluminized & overcoated

10 inch f/5.6	$129.50
10.1 inch f/4.5	$134.50
12.5 inch f/6	$249.50
13.1 inch f/4.5	$254.50
17.5 inch f/4.5	$590.00

Elliptical Diagonals
1.83" — $15.50
2.14" — $18.95
2.60" — $22.50
3.10" — $ 34.50
4.25" — $ 69.50
6.25" — $150.00

EASY TO ORDER . . . Phone or mail your order in today. Visa/MasterCard accepted. All telescopes are shipped freight charges collect. All mirrors are shipped prepaid in the contiguous U.S.A. No sales tax on out-of-state orders. Phone orders Mon-Fri 8 am-4:30 pm local time.
Call 1-714- 659-4621

- **30 days returnable**
- **30 days exchangeable**
- **2 years materials and workmanship**

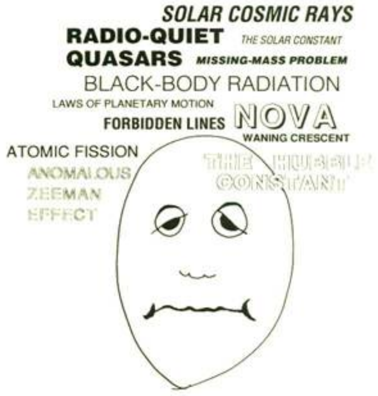
Coulter Optical, Inc.
P.O. Box K
Idyllwild, CA 92349-1107
"OPTIMUM OPTICS AT MINIMUM COST SINCE 1967"

tial objects displaying spectral lines from elements under highly unusual conditions, they called the lines *forbidden.* But the lines aren't forbidden in nature, they are just forbidden in the laboratory.

The Anomalous Zeeman Effect

Strong magnetic fields split spectral lines. This fact, first noted by Dutch astrophysicist Pieter Zeeman in 1896, is now called the Zeeman effect in his honor. After the discovery, Zeeman and other early researchers concentrated on studying the line triplets that classical physics could explain.

But many astronomical objects had unusual spectra that showed "anomalous" splitting into different numbers and different spacings than classical physics could account for. Quantum mechanics now deals with these effects nicely; they even sparked an understanding of the important concept of electron spin. Unfortunately for language purists, however, the earlier term is still in use, even though astrophysicists now know that the *anomalous Zeeman effect* is really the commonest kind of Zeeman effect.



Radio-Quiet Quasars

In the early 1960s, radio and optical astronomers teamed up to identify sources of radio emission. Until then the relatively poor resolution of radio telescopes precluded accurate positions.

Clever techniques identified some pointlike sources that looked like bluish stars but which had the most bizarre spectra ever seen. These were dubbed quasi-stellar radio sources. The initials QSRS were first pronounced, and then spelled, quasars.

As time went on optical astronomers found lots of these blue starlike points with puzzling spectra, but most turned out to be undetectable by radio. These were promptly dubbed *radio-quiet quasars.* But that really means radio-quiet quasi-stellar radio sources, or radio-quiet radio sources!

The Missing-Mass Problem

One of astronomy's biggest problems hinges on identifying a lot of material that no one can see. Some years ago astronomers discovered that many galaxies, including ours, contain about ten times more matter than can be seen in any kind of telescope. We know it's there because the gravitation of the invisible stuff tugs measurably on the stuff we can see. This discrepancy is known as the *missing-mass problem.*

But the problem is badly misnamed, protests Princeton astrophysicist Jeremiah Ostriker. "The problem is not that the mass is missing. The problem is that it's *there!"* Lately, however, a few astronomers have started calling this the *unseen-mass problem* or the *missing-light problem,* so there's hope this oxymoron might yet disappear.

Black-Body Radiation

Astrophysicists call an object which absorbs all the radiation falling on it a black body. Physics then tells us that this black body thermally reradiates all the energy it has absorbed. Physicists, with totally straight faces, call this process *black-body radiation.* In other words, in physics every black body emits light.

Laws of Planetary Motion

Ancient skywatchers noticed that most points of light in the sky stay fixed relative to each other, but a few bright ones moved at varying speeds and in apparently irregular ways. They therefore called these unruly moving stars planets, from the Greek *planetes,* meaning wanderer.

Then in the 1600s, Johann Kepler and Isaac Newton uncovered the regularities that underlie the seeming disorder of planets' motions. While this was greatly satisfying to astronomers, it yields nonetheless an oxymoronic expression the *laws of planetary motion* — or, in other words, the rules by which the wanderers don't wander.

Solar Cosmic Rays

Discovered in the early 1900s, cosmic rays were named for the way they impinge on Earth's upper atmosphere from space. At the time these very high-energy particles were not easy to track

ASTRONOMY CAMPS FOR ADULTS AND STUDENTS

The University of Arizona
in Tucson, Arizona,
The Astronomy Capital
of the World,
is proud to present
astronomy camps for
teenagers and adults.

Activities include:

1. Lectures from UA Steward Observatory astronomers.
2. Viewing of Celestial objects through 8" portable telescopes and both 40" & 60" telescopes on Mount Lemmon.
3. Tour of Mirror Laboratory.
4. Lectures and films on topics from the solar system to cosmology.
5. Application of computer technology.

Camp dates:
Adults - April 6-8;
Teenagers (Basic) -
June 2-9 & 9-16;
and Teenagers (Adv.) -
June 16-23.
Cost: Adults $150
Teenagers $485

**To register, call Joan Morrill
at 1-800-232-8278**
In Arizona: 621-5233

THE UNIVERSITY OF
ARIZONA
ALUMNI ASSOCIATION

TELESCOPE DISCOUNTS
MIBRO COMPANY

ORDERS ONLY CALL TOLL FREE
1-800-223-0322

Meade
MEADE 97E-2
3½" SPOTTING SCOPE
$318
MEADE 97E....$348

Meade
MEADE 97ER-2
RUBBER COATED
3½" Spotting Scope
$348
MEADE 97ER...$408

Meade
MEADE Premier 2080
•MODEL 30 •MODEL 50
•MODEL 70
8" f/10 Schmidt-Cassegrain Telescope
ALL MODELS IN STOCK
GREATLY DISCOUNTED

Meade
MEADE Premier 2080
•MODEL 36 •MODEL 56
•MODEL 76
8" f/6.3 Schmidt-Cassegrain Telescope
ALL MODELS IN STOCK
GREATLY DISCOUNTED

Meade
MEADE Premier 2120
•MODELS 30 • 50 • 70
•MODELS 36 • 56 • 76
10" Schimdt-Cassegrain Telescope
ALL MODELS IN STOCK
GREATLY DISCOUNTED

Meade
MEADE 2045D
4" Schmidt-Cassegrain Telescope
$678
Meade-Refractor
Newtonian Telescope
ALL MODELS IN STOCK

Meade
MEADE GIANT Binoculars
•MEADE 11X80...CALL
•MEADE 20X80..CALL
•MEADE 11x80R..CALL
•MEADE 20x80R..CALL
COMPLETE LINE OF
CELESTRON-NIKON
LEITZ-BINOCULARS
Call For Low Prices!!

Meade
MEADE Telescope Accessories
•ORTHOSCOPIC EYEPIECES
•SUPER PLOSSL EYEPIECES
•EQUATORIAL WEDGE
•OFF-AXIS GUIDER
•Telenegative Amplifier
•FILTER KITS
ALL IN STOCK
GREATLY DISCOUNTED

CELESTRON
CELESTRON C-90
3½" Spotting Scope
$358
CELESTRON C-90
Super Conversion Kit
IN STOCK!!

CELESTRON
SUPER POLARIS C-8 WITH STARBRIGHT COATING
8" Schmidt-Cassegrain Telescope
$1068
CELESTRON
Ultima 8.....$1,748

All merchandise brand new factory fresh. Prices subject to manufacturers increaseidecrease. Minimum shipping $9.95. Shipping charges non-refundable. Refund within 7 days with all original packaging. For money orders call for order number. Customer service call 11am-5pm. Pictures are for illustration purposes and may not be exact. Consumer Affairs License No. 800-253.

N.Y. RESIDENTS (212) 695-7133
CUSTOMER SERVICE (212) 967-2353
VISIT OUR RETAIL LOCATION
64 WEST 36th ST., N.Y.C., N.Y. 10018
MONDAY-SATURDAY 10:00AM-7:00PM
SUNDAYS 10:30AM-6:00PM

back to their presumably cosmic sources.

However, space probes have since demonstrated that a lot of cosmic rays actually come from the Sun rather than from any more distant source. Yet while admitting the paradox, astronomers still call them *solar cosmic rays.*

Atomic Fission

Atomic fission may be the most perfect oxymoron ever coined. Atom comes from Greek, with *a-* meaning not, and *-tom* meaning cut or split. An atom therefore is that which is unsplittable.

When you slam atomic nuclei together, they fuse and release energy. The Sun generates its power by fusing hydrogen atoms to make helium atoms. When you split atoms apart, however, you also get energy, though not as much. This process is called fission, and it drives nuclear power plants. *Atomic fission* is therefore a wonderful oxymoron: *atom* means you can't split it, but *fission* says you just did.

The Hubble Constant

For about fifty years cosmologists have sought to measure how fast galaxies are moving away from one another. Edwin Hubble pioneered this work, so the number that defines the rate of recession (in kilometers per second per million parsecs) is called the *Hubble constant.*

The trouble is cosmologists still haven't pinned that number down! Hubble himself claimed it was 500, but over the years the constant has dropped to 200, then to 120, then 70, and a few years ago it was claimed to be as low as 47. (Some wise-guy astronomer then derived an equation that described the decline of the constant and called it "Hubble's 2nd-order constant.") The battle now rages on between the camp that champions 100 and the one that claims 50. Astronomers hope to resolve the matter with the Space Telescope.

As with the missing-mass problem a solution may yet emerge, whatever the numerical value turns out to be. Until then, while more than one astronomer has sarcastically called the number the *Hubble variable,* many astronomers have taken to labeling it the *Hubble parameter.*

These are my favorite astronomical oxymorons. Anyone want to try adding to the list? And by the way, what stories have you heard to explain the term *right ascension?* — *Norman Sperling* ☐

OVER 100 PRODUCTS FROM JMI!
Average Installation Time: 15 min.
No Drilling Required.

1. MOTOFOCUS for 2080/2120 LX5 & LX6 Completely compatible with manufacturer's dual-axis hand control **$98.50**

2. MOTOFOCUS FOR C-5/C-8, C-11/C-14 (Specify age) **$98.50**

3. MOTOFOCUS FOR 2080/2120 LX2, LX3, MTS, GEM (Shown with LX3 attachment) **$98.50**

4. MOTOFOCUS for Celestron and Meade refractors, Meade Newtonians, Astro-Physics 2"/2.7", Parks 2", Renaissance/Genesis, University 2", Takahashi and Brandon. (Specify) **$98.50**

5. NEW! MOTOFOCUS for Tectron low-profile focuser **$98.50**

6. NEW! AVAILABLE SOON. JMI 2" low-profile focuser with built-in MOTOFOCUS. Unique design totally eliminates side-slop **$219.00**

7. DELUXE C14 MOTOFOCUS. Controls R.A./Dec/Focus **$159.00**

8. MOTOFOCUS FOR B&L 4000 ...... **$98.50**

9. MOTODEC Push-on for all Meade fork-mounted telescopes: 2080/2120, LX2, LX3, LX5, LX6 and MTS line **$89.95**
The only Dec. motor you can get:
- With variable speed.
- Without unsightly gears or belts.
- Plus all the things you expect: easy-on/easy-off, friction clutch, compatible with manufacturer's hand control and looks so good, you'll think it is original equipment. Patented.

10. MOTODEC Snap-on for C-8 with variable speed **$89.95**

11. MOTODEC Snap-on for 2045/B&L 4000 and 8000 (Specify). With variable speed **$89.95**

12. MOTODEC Push-on for Meade 6600/8800/295/310/320 .... **$79.00**

13. MOTODEC for Polaris/Super Polaris/GEM (Specify) **$98.50**

14. MOTODEC Snap-on for C-11 ...... **$98.50**

Most of our products are shipped in special die-cut foam boxes, #15-18 are examples of our high-tech packaging.

15. MOTOTRAK G the only triple-control drive corrector made for Meade GEM 2080/2120/440, 295, 310, 320, 6600, 8800. Quartz driven, equipped with 2X and 4X, with R.A. motor **$229.00**
MOTOTRAK G w/ R.A. & dec. motor ... **$308.00**
MOTOTRAK G w/ R.A. & dec. & focus . **$359.00**

16. MOTOTRAK III, the only triple control drive corrector made. Pulse width & map light. 110VAC, 10 watts, R.A. correction, two speeds. Quartz driven.
MOTOTRAK III **$249.00**
MOTOTRAK III-B built-in battery pack) with free MOTOFOCUS or MOTODEC **$329.00**
MOTOFOCUS III-B MOTOFOCUS & MOTODEC **$389.00**
ADD $5.00 SHIPPING for #16 only

17. DSC-MAX. Absolutely the latest technology in digital setting circles. (See scopes listed below). **$489**

18. NGC-MAX. A dedicated computer that will guide you to over 8,000 objects with information on each. (See scopes listed below) **$789**

19. SGT-MAX. Full feature planetarium software with interface to most popular telescopes. Simultaneous telescopic/naked-eye views, zoom from 180° to three arc-seconds. Specify disk type and telescope. (For IBM compatibles). **$699**
SD, NGC, and SGT all use 4000 bit encoders for 0.09° resolution and fit 2080/2120/2045, LX2, LX3, LX5, LX6, MTS, GEM, C-11, C-14, B&L4/8, Dynamax 8, DS10/16, Meade 628/645/826/856/880/1060/1266.

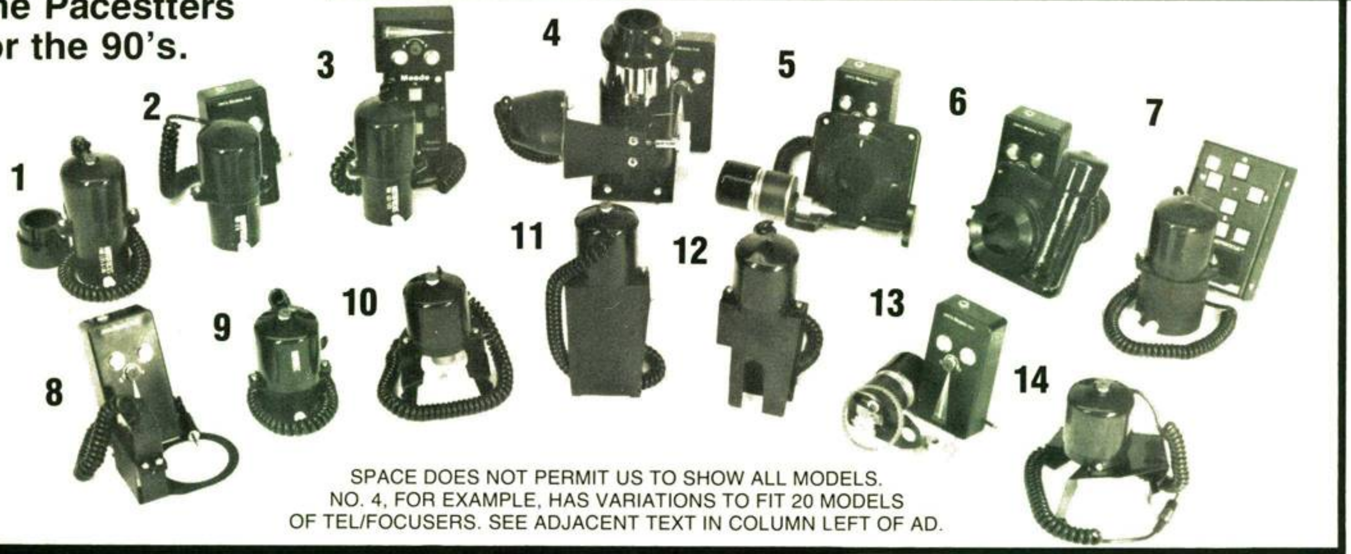
JMI!

The Pacestters for the 90's.

MOTOFOCUS ENDS THE FOCUSING WIGGLES.

"A few months ago I purchased a MOTOFOCUS for my 8" SC and I have never been so happy or excited over a purchase. It is fantastic and worth every cent...It is by far the single best purchase I have acquired. Frankly, I was getting very discouraged and had considered giving up viewing because of the wiggles."

Fred Mumm



SPACE DOES NOT PERMIT US TO SHOW ALL MODELS.
NO. 4, FOR EXAMPLE, HAS VARIATIONS TO FIT 20 MODELS
OF TEL/FOCUSERS. SEE ADJACENT TEXT IN COLUMN LEFT OF AD.

"A very hearty thanks to JMI for making my 2080 LX5 a fun-packed experience. I am the happy owner of your new NGC-MAX. Never have I seen so much in such little time. And best of all it was so simple."

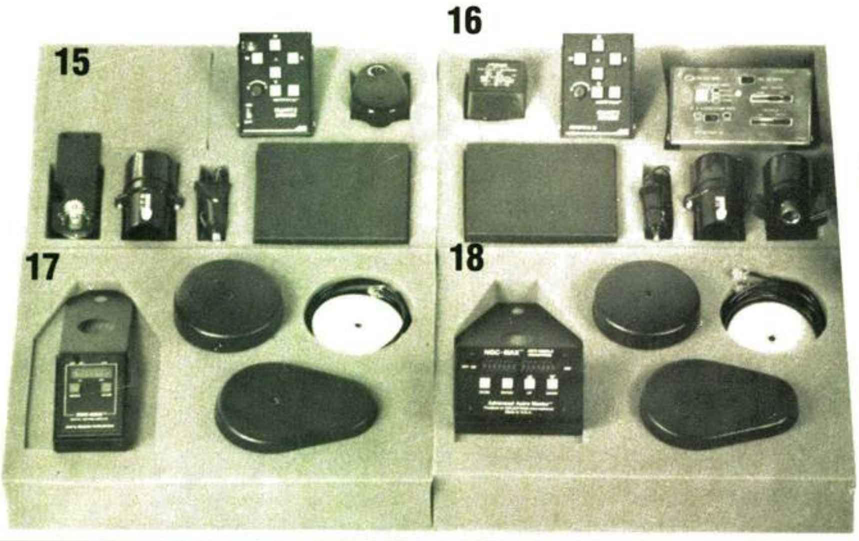
Joseph Farrar

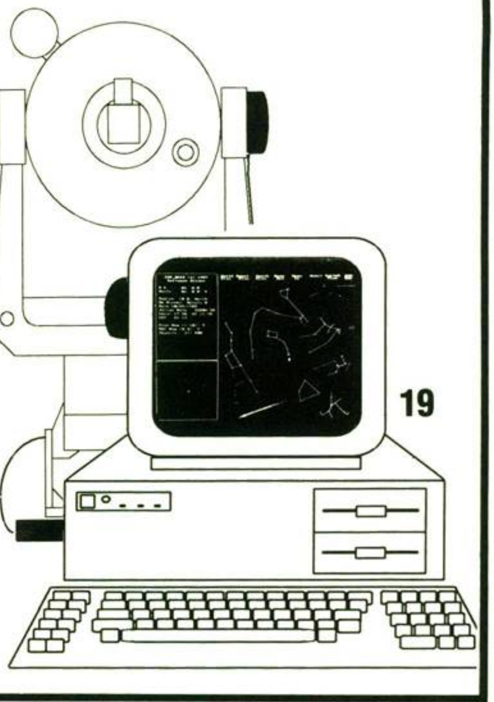
"The NGC-MAX has revolutionized my Meade 2045-D. I am one satisfied customer."

Jim Freeman, CT

"I love the NGC-MAX...It is the best accessory I have seen for my 2120 LX5. Your products are the best, compared to any competing units."

Jim Clark, CA





NGT-18: NEXT GENERATION TELESCOPE

(Shown with nose assembly retracted)

- EQUATORIALLY MOUNTED
- 18" f4.5 NEWTONIAN
- 36" split-ring design
- Serrurier truss rods snap apart
- Internal battery operated QUARTZ
- Rotating nose assembly
- Stepper motor 2X, 4X
- Motofocus - Motodec
- Digital RA/DEC display

NGT-18D $7900
(50% DEPOSIT REQUIRED)

JIM'S MOBILE IND.

INFO & SERVICE (303) 277-0304
ORDER LINE . . .(800) 247-0304
1960 County Road 23 • Evergreen, CO 80439
FAX: (303) 526-9140
Hrs. M-Th. 8:30-5:30 Fri: 8:30-4:30 MT

PHONE/MAIL ORDER: VISA, MasterCard, personal check or money order. USA & CANADA shipping paid. **OVERSEAS:** Send VISA, MasterCard numbers with expiration date, or bank check in US$; add 5% shipping overseas only.

Ultima/Powerstar Products:
See Celestron Dealer

THE UNIVERSE THROUGH A SMALL SCOPE

Deep-Sky Observing with Small Telescopes by David J. Eicher and the Editors of *Deep Sky,* (Enslow Publishers, 1989), ISBN 0-89490-075-7, softcover, 336 pages, $29.50.

Tucked away in your garage or closet, behind the umbrellas, rubber boots, and skis, may well be a forgotten telescope in the 2- to 6-inch range. In all likelihood, the telescope was put away because you considered it too small. "And why not?" you ask. "After all, you need a large-aperture telescope for deep-sky observing." But *Deep-Sky Observing with Small Telescopes* takes issue with this assumption. In fact, David Eicher and the other authors inform us that that there are upwards of 10,000 deep-sky objects visible in small telescopes.

The book is a series of articles written by experts along with a comprehensive catalog listing numerous examples of each type of deep-sky object. Double stars are covered by Glenn F. Chaple, Jr.; variable stars, globular clusters, and bright and dark nebulae by David Levy; open clusters by David Eicher; planetary nebulae by F. Michael Witkoski; and finally galaxies by Alan Goldstein. Observers will find plenty of information in each chapter.

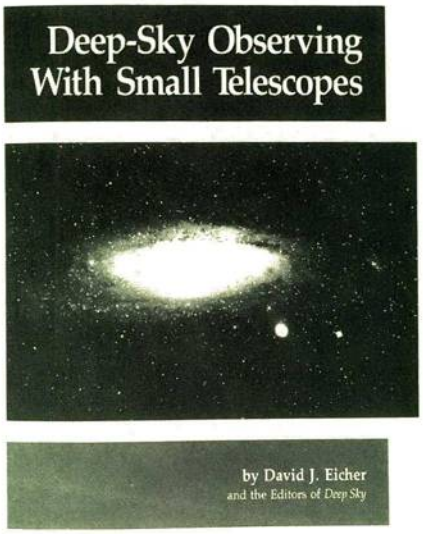
After a preface by the dean of deep-sky observers, Walter Scott Houston, and a foreword by Eicher, amateur Kevin Ritschel introduces us to the subject of deep-sky observing. His introduction, though not comprehensive, leads the reader into the subsequent chapters where the best observing methods to use and the types of objects worth looking for are discussed in detail.

Each chapter begins with a short introductory statement by the author. These little introductions give a personal slant to the subject and help the reader identify with the writer. A short biography presents the authors' qualifications and affiliations.

The chapters get underway with a brief historical perspective that lends the subject a continuity for the present-day observer. The double-star observer scrutinizing a difficult pair of stars, for example, can identify with the famous Struves or S.W. Burnham as he or she strives to obtain the most from a small telescope.

The chapters also offer concise explanations of complex matters, such as beginning and advanced observing techniques. This is obviously an attempt to appeal to both beginners and advanced amateurs, and it serves both very well. Overall, the beginner should feel comfortable with the descriptions of the objects and the observing hints while the advanced observer will enjoy contemporary information presented in a style similar to *Burnham's Celestial Handbook.*

The descriptions of the objects themselves are obviously made by experienced observers. Beginners are likely to find them a bit more detailed than their own observations. A caution to this effect is aired by David Levy who writes, "Descriptions of these [objects] should by taken with a grain of salt, since telescopes, individual observing skills, sky conditions, and other factors conspire to give different observers dramatically differing impressions of the same objects." Advanced observers will likely read many of these descriptions with a slight case of envy, wishing to experience the dark-sky conditions under which the authors' observations were made.



The texts in these chapters are, in general, easily read and understood. On occasion, however, an author introduces a term or concept that may be too complex for the beginner. Cases in point are Levy's use of "absolute magnitude" and the abbreviation "kpc" for kiloparsec, both of which are introduced without a definition. Readers of other handbooks and references, however, will find no difficulty in following this type of presentation.

Another annoyance is the multitude of typographic errors. In some cases sentences are misplaced and entire words are omitted. Some of the worst examples are Greek designations for stars, which should, at least, have been drawn in.

The reference sections of the book are catalogs in a tabular style. Catalog numbers are given, usually in NGC or Messier designations. Occasionally, though, the reader is given designations that are mysterious at best. This is especially noticeable in the chapters on double stars and variable stars. The beginner would have been better served with an insert explaining the various classification systems. While many may be familiar with Struve's capital Sigma designation for double stars, others will be puzzled. The catalog also gives coordinates in epoch 1950, and I can't really decide just why. Perhaps the material was gathered before epoch 2000 coordinates were available and correcting for precession would have been a tough task.

The magnitudes, angular sizes, and classes given will prove helpful to any observer wishing to confirm the vital statistics of objects. Many of the catalog entries have descriptive or explanatory notes appended. These make the catalog much more interesting and are actually enjoyable reading in their own right.

As a reference book, the 7" by 10" paperback is likely to get a lot of use, both at home and in the field. A hardback with a sewn binding would have been nice. Given the price per copy, I'd be willing to pay a bit more for the more substantial binding.

The book is illustrated with numerous photographs of the objects discussed. The illustration credits are a Who's Who of expert astrophotographers and sketchers. The reproduction quality, however, runs from really good to fairly poor. Some of the photos of planetary nebulae make it tough to differentiate between the nebula and field stars, while several of the globular cluster photos are so heavily overexposed that the central regions are burned out. Drawings are black-on-white — essentially a negative rendition of the eyepiece reality. Although some of the drawings suffer from the usual lack of faithful reproduction, they do give the observer a useful starting point for what he or she might expect to observe through a small telescope.

Small-scope owners suffer from a paucity of readily available information on the differing deep-sky delights. *Deep-Sky Observing with Small Telescopes* fills a gap that has been rankling amateurs for many years. Even those with huge light-buckets will find a lot of very useful information in these pages. In fact, the content of the book suggests a quality that deserves a better job of editing, proofreading, and binding. Perhaps a subsequent printing will fix the little problems and help to make the book a classic that deserves a place alongside *Burnham's Celestial Handbook*. — *Leon Knott*

A THEORY OF PERIODIC DISASTER

Nemesis; The Death Star: The Story of a Scientific Revolution by Richard Muller, (Weidenfeld and Nicolson, 1988), ISBN 1-555-84173-2, hardcover, 194 pages, $17.95.

I liked this book for its discussion of the killer-star scenario of mass extinctions as much as its detailing the genesis of a scientific theory. Muller's Nemesis theory is simple: A dwarf-star companion to the Sun — almost too faint to detect in telescopes — has an orbital period that brings it close to the Sun every 26 to 30 million years. When it does, it rains comets and asteroids on the inner solar system, precipitating mass extinctions.

It was Luis Alvarez, working with his son Walter and nuclear chemists Frank Asaro and Helen Michel, who first proposed that an asteroid impact with Earth wiped out the dinosaurs 65 million years ago. Muller merely took their work one step further after reading a "crazy paper" by paleontologists David Raup and Jack Sepkoski that asserted that the Cretaceous catastrophe and other mass extinctions took place every 26 million years. (Read Raup's ideas about this theory in his book *The Nemesis Affair,* published in 1986 by W. W. Norton.)

Nemesis details the derision Muller's theory evoked from other scientists, his own doubts and frustrations, and what it's like to have faith in a theory. Whether or not you think Nemesis exists, Muller's story is a fascinating saga

SETI Pioneers

Scientists Talk About Their Search for Extraterrestrial Intelligence

by David W. Swift

John Billingham
Ronald Bracewell
Melvin Calvin
Giuseppe Cocconi
Frank Drake
Freeman Dyson
Nikolai Kardashev
John Kraus
Philip Morrison
Bernard Oliver
Carl Sagan
Kunitomo Sakurai
Charles Seeger
Iosef Shklovskii
Jill Tarter
Vasevolod Troitskii

Why did some scientists first decide to conduct a search for extraterrestrial intelligence? What factors in their lives predisposed them to such a quest? What obstacles did they encounter along the way? These interviews with the first scientists involved in the search offers a fascinating overview of the emergence of this modern scientific endeavor. A concluding interview with Paul Horowitz surveys the Pioneers' contributions.

435 pages, illustrated. $35.00.

The University of Arizona Press
1230 N. Park Ave., Tucson AZ 85719
VISA/MC call1-800-426-3797

Telescopes & Accessories from
Wholesale Optics of Pennsylvania

Tele Vue "Tops in the Field"
We carry and stock the full line of world famous Tele Vue Eyepieces, Scopes & Accessories
New style plossls, wide fields, naglers, Genesis Oracle 3 & Para Corr in stock
1¼" Paracorr .... $189 2" Paracorr $295

TELRAD® w/Base $38.00
Extra Bases.....$7.95

2" Celestron Eyepiece Closeout
18 or 20mm Ortho. . .$79.95
60 or 70mm Kellner .$74.95
Supplies Limited

PORTA-PAC $65.00
12 AMP HR. Heavy Duty PORTA PAC........$84.95

QUARTZ DRIVE CORRECTORS BY VOGEL — ALL DIGITRAK II
SINGLE AXIS
VE-200 Runs off DC $121.95
VE-300 Runs off DC/AC $141.95
VE-400 Runs off DC/AC or Int. Battery $186.95
DUAL AXIS
VE-200 D $164.95
VE-300 D $199.95
VE-400 D $249.95
VE-100 Inverter (converts your motor to DC $64.95

THOUSAND OAKS SOLAR FILTERS *THE BEST!*
Get Ready for 1990's Solar Sunspot Maximum
Type I 8" $84.95 Type I 10" $94.95
Type II 8" $114.95 Type II 10" $124.95
All sizes available for all scopes. Type III for photography now avail.

SOLVE FOCUS PROBLEMS FOREVER
with Spectra's Sure-Sharp Optical Grid Focusing method for perfectly focused astrophotos.
All Spectra accessories avail. **$119.00**

JIM'S MOBILE
Moto-Focus LX3/5/6 . . .$77.00
Moto-Decs LX3/5/6. . . .$75.00
NGC MAX/DSC-MAX/ SGT MAX .... Call
Focusers & Decs — most scopes avail.

Tectron Collimators improve Newt. images w/the following
Sight Tube........$28.00
Cheshire E. pc. . . .$36.00
Auto-collimator . . .$30.00
Above 3 w/Bklt . . .$92.00
Fast Scope Owners!
Ultra Low Rack & Pinion Focusers
2" w/1¼" Adptr. $118.00
Photographic Focuser .$159.00

EDMUND SCIENTIFIC
Astroscan 2001
4¼" Portable Reflector Scope
$282.00
All Accessories Avail.

BINOCULAR SALE
We carry Zeiss • Fujinon • Swarovski • Steiner • Nikon • Swift • Celestron • Meade • Kowa
Contact us for prices!

B&L 8 × 50 FINDER
St. thru $46.95
BKTS: Spec. SCT or Newt. **$22.00**
5 × 24 Rt. Angle.$37.95
6 × 30 Rt. Angle.$42.95

BOOKS & STAR CHARTS
MAG 6 Star Atlas.......$15.95
Uranometria Vol. I or II . .$39.95
1000 Plus $39.95
Sky Atlas 2000-Field. . . .$16.95
Sky Atlas 2000-Color . . .$39.95
We carry a full line of astronomical books & publications.

EDMUND SCIENTIFIC
1¼" RKE 8, 12, 15, 21 or 28MM $37.95
RKE 2.5X Barlow $58.95
1¼" Orthos 4, 6, 12.5, 18 or 25MM $48.95
Ortho Zoom 8.4-21MM........ $89.95
1¼" Kellners 6, 9, 12, 18 or 25MM $32.95
1¼" Erfle 20MM $49.95
2" 32MM Wide Field Erfle $115.00
ALL EDMUND PRODUCTS AVAILABLE

"ACCESSORY SPECIALS"
T-Rings..................$10.00
Tele-Extenders...........$22.00
T-Adapters...............$22.00
Color & Moon Filters $13.00
B&L Pro Plossls 26-35MM. .$49.95 ea.
.965 2.5X or 3X Barlow $18.00
Celestron .965 Star Diag..........$10.00
Drives for Tasco $89.95
Meade 7MM R. Gr. Ortho $45.95
1¼" 32MM Erfle $50.00
1¼" Wireless Illum., Dual Cross Hair Reticle 12MM Ortho..........$74.95
All Meade and Celestron accessories available.

Contact us or visit our showroom at Pocono Mountain Optics for savings on all scopes, accessories & binoculars.
New Celestron Ultima 11 & New Meade Premier Series & New Model Schmidt Cass now available.

MEADE • CELESTRON • TELE VUE • B&L • BRANDON • PARKS • EDMUND • UNIVERSITY OPTICS • JMI • THOUSAND OAK FILTERS • SWIFT

Wholesale Optics of Pennsylvania
North Pocono Village Shopping Center
RR 6, Box 6329, Moscow, PA 18444

Call till 9 PM: (717) 842-1500
FAX 717-842-1408 24 hrs.

WORLDWIDE SHIPPING
Speak with amateur astronomers . . . Ask for Glenn-ARS: K3WEI
P. List send SASE
3% Cr. Cg.
Cat. $3.00
ULTRA LOW SHIPPING

focus camera

$18 VALUE **FREE** $18 VALUE
focus ASTROPACK
- Guide to Astronomy
- Astrophotography Basics by Kodak
- Professional Optical Maintenance Kit

w/Purchase of Any Telescope

For over 20 years we have been serving customers nationwide with all their photographic & astronomical needs. We invite you to join our thousands of satisfied customers. Call our knowledgeable sales staff today & save.

Enjoy Astronomy At Down To Earth Prices

For Orders Only Call **800-221-0828** Information Hotline **(718) 221-0828**

We Ship Only Brand New Latest Model Factory Packed Telescopes

Meade TELESCOPES & ACCESSORIES

SAVE UP TO $1000 ON MEADE ACCESSORIES
Buy a Meade 2080 or 2120 Basic, LX3, LX5, LX6 or Premier Telescope from **Focus Camera** between now & March 31 & receive a Meade $1000 coupon book good for discounts on selected Meade Accessories from our already low prices

2080 BASIC SCHMIDT CASSEGRAIN TELESCOPE
- 8 inch F/10 Schmidt Cassegrain Optical Tube
- Precise Worm Gear Clock Drive
- Built-in Manual Slow Motion Controls for precise positioning
- Optional *MCOG* Multi-Coatings

Complete Factory Pack includes: Tripod & Wedge, Diagonal, 25mm 1¼" Eyepiece, 6x30 Finderscope....

MEADE $1000 COUPON BOOK WITH PURCHASE **$897**

2080 Basic MCOG w/Multi Coatings .... **CALL**

2080 LX3 "Best Selling Telescope for Astrophotography"
- Accurate Electronic Quartz Controlled LX3 Drive System for Precise Tracking.
- 8 inch F/10 Schmidt Cassegrain Optical System
- MCOG Multi-Coated Optics Group
- AC or DC Operation for easy field use

Complete Factory Pack Includes:
Tripod & Wedge, Diagonal, 25mm 1¼" MA Eyepiece 8x50 Finderscope, AC Adapter, DC Car Cord, Case

MEADE $1000 COUPON BOOK WITH PURCHASE **$1268**

2120 LX3 10 inch LX3 Telescope Same As Above w/Hand Controller **$1637**

2080 LX5
- 8 inch F/10 Schmidt Cassegrain Optical System
- LX5 Quartz Controlled Electronic Worm Gear Drive System for precise tracking w/scanning
- MCOG Multi-Coated Optics Group • N/S Operation
- Includes ECC Electronic Command Center for complete drive system control
- Three Way AC, DC or Battery Operation

Complete Factory Pack Includes:
Tripod & Wedge, Hand Controller, 2 inch Diagonal, 26mm Super Plossl Eyepiece, 9x60 R.A. Polar Illuminated Finderscope, AC Adapter, DC Car Cord, AA Battery Pack & Case

MEADE $1000 COUPON BOOK WITH PURCHASE **$1494**

2120 LX5 10" Same As Above *SPECIAL LOW PRICE* **$1838.95**

LX6 WIDE FIELD SALE
LX6 Telescopes Offer
59% Wider Field of View
60% Less Photo Exposure Times
Optional Digital Readout
State-of-the-Art LX6 Drive

2080 LX6 8" 1280mm F/6.3 Complete Outfit **$1749**
2120 LX6 10" 1600mm F/6.3 Complete Outfit **$2329**
2120 LX6 SW 10" LX6 with Super Wedge .... **CALL**
Digital Readout Option **337**

SAVE UP TO $1000 ON Meade ACCESSORIES WITH YOUR PURCHASE OF A 2080 OR 2120 LX6

SAVE OVER $500

312 Refractor Sale!
"Perfect Beginner's Scope"
See the craters on the moon, Saturn's rings, Jupiter's cloud belt and Much Much More ....
This Advanced 3.1" Refractor Yields 78% Brighter Images Than Most Beginner's Scopes ....

Complete Outfit Includes: Full Height Field Tripod, High Quality Alt-Azimuth Mount w/Slow Motion Controls, 90° Diagonal 5x24 Finderscope, 25mm 1¼" (36x) Eyepiece, Built-in Dew Shield
Limited Quantity At This Price
(Meade Suggested List $950) **$368.95**

Special 312 Accessory Packages

Terrestrial Package
- 45° Erect Image Diagonal For Terrestrial Viewing
- 12mm 1¼" (76x) Eyepiece

$78.95 (Meade List $145)

Astronomical Package
- Meade 9-7mm Super Plossl
- Meade Series 4000 2x Barlow
- Meade Sky Maps

$159.95 (Meade List $330)

Meade Newtonian Reflectors

4420 New 4.5 inch Equatorial Reflector w/Tripod & 5x24 Finderscope **$376**

MTS Schmidt Newtonions
Include: Equatorial Pier Mount, 25mm 1¼ E.P., Deluxe Focuser
Free: Setting Circles (49.95 Value) w/Scope Purch.

	Basic Scope	w/788 Drive	w/LX3 Drive
SN6 (6 inch)	517.95	586.65	748.95
SN6-MCOG (6 inch)	572.95	594.95	804.95
SN8 (8 inch)	699	759.95	899
SN8 MCOG (8 inch)	759	817	975

#66A Dec Arm **39**
6x30 Finderscope **45**
#66C Dec Arm **50**
8x50 Finderscope **72**

826C 8 inch F/6 Newtonian Reflector w/Equatorial Mount & Pier **$879**

DEEP-SPACE TELESCOPES
DS-10A 10" f4.5 Ultra-Sharp Reflecting Telescope w/Motor Drive, Setting Circles and Deluxe Focuser **$838**
DS-16A 16" Reflector. Gathers 4 Times as Much Light as an 8" Scope! Includes Motor Drive, Focuser & 1¼" Eyepiece..... **$1768**

Meade REFRACTORS
#224 2.4" Beginners Scope **142**
#290 60mm Equatorial **259**
#323 3-1" **Equatorial** 900 mm f/11 Complete Outfit w/**Tripod** **$468.95**

Meade SPOTTING SCOPES
A WHOLE LOT MORE THAN MEETS THE EYE!
LIFETIME WARRANTY

97E-II Erect Image Spotting Scope, **Great Value!**
- 3.5" 1000 mm f/11 Meade Optics
- 5x21 Erect Image Finder
- 45° Erect Image Diagonal
- 40x Eyepiece • Focusing Scale

4-Pc Complete Outfit **$319**
97ER-II Same as 97E-11 w/Rubber Coating **$359**
PATHFINDER II 15-60x Razar Sharp Compact Spotter **$179.95**

Meade Telescope Accessories
We Carry A Huge Inventory of Meade Telescope Accessories. Call or Write for our Discount Prices!

CAT-COMPUTER AIDED TELESCOPE
- Locate any of over 8000 Astronomical Objects in less than ten seconds! • Highly Accurate • Easy to Use • Simple to Install
- Optional CAT-COM RS-232 Computer Interface

#9000 (2080) **835**
#9001 (2120) **835**
CAT-COM .... Add **$139**
#9008 (2080 Lx6) **838**
#9010 (2120 Lx6) **838**
CAT f/Celestron .... **CALL**

DSC Digital Setting Circles Specify Telescope Model **$397**

NEW **Meade Drive Correctors**
#43 Single Axis (2080 Basic DS-10A, DS-16A, SN-6, SN-8) **78**
#46 Dual Axis (2080 Basic, SN-6, SN-8) **265**
#47M Dual Axis (DS-10A, 826C) **245**
#48RS Dual Axis (DS-16A) **294**

Meade Series 4000 Eyepieces: "Clearly the Finest Available"
Our Prices Are Too Low to Print Here
Call or Write For Our Super Low Prices

of the intellectual work done by scientists as they traverse totally new and uncertain ground. —*Jeff Kanipe*

LUNAR ECLIPSE CATALOG

Fifty-Year Canon of Lunar Eclipses: 1986 — 2035 by Fred Espenak, (NASA Reference Publication 1216, March 1989), softcover, 225 pages, $28.95 plus $3.00 shipping. (Order from National Technical Information Services, 5285 Port Royal Road, Springfield, VA 22151.)

The *Fifty-Year Canon* is a catalog describing the eclipse paths and global maps of every lunar eclipse from 1901 through 2100. Section one is a catalog of eclipses for the two-hundred-year period, and section two follows up with eclipse paths and global maps.

It is section three, however, that will no doubt interest many amateur astronomers. Focusing on the next fifty years, Espenak presents diagrams showing the Moon's path through Earth's shadow for 114 eclipses. Maps of Earth show regions of maximum visibility for all phases. Espenak's world maps are similar to those appearing in *The Annual R.A.S.C. Observer's Handbook*. Explanations are provided for interpreting the diagrams. Appendices discuss lunar eclipse geometry, frequency, recurrence, crater timings, eclipse brightness, and time determination. A simple FORTRAN program that can be used to predict lunar eclipses is provided at the back of the book. —*Jeff Kanipe*

BOOKS RECEIVED

General Astronomy

Cosmic Perspectives, edited by S. K. Biswas, D. C. V. Mallik, and C. V. Vishveshwara, (Cambridge University Press, 1989), ISBN 0-521-34354-2, hardcover, 249 pages, $49.50.

The Guinness Book of Astronomy by Patrick Moore, (Sterling Publishing, 1988), ISBN 0-85112-375-9, hardcover, 288 pages, $19.95.

Astronomy: The Cosmic Journey, fourth edition, by William K. Hartmann, (Wadsworth Publishing, 1989), ISBN 0-534-09579-8, hardcover, 698 pages, $43.25.

Discovering Astronomy, second edition, by R. Robert Robbins and William H. Jeffreys, (John Wiley and Sons, 1988), ISBN 0-471-83211-1, softcover, 480 pages, $39.95.

Horizons: Exploring the Universe, third edition, by Michael Seeds, (Wadsworth Publishing, 1989), ISBN 0-534-09792-8, softcover, 518 pages, $38.00.

Merlin's Tour of the Universe by Neil De Grasse Tyson, (Columbia University Press, 1989), ISBN 0-231-06924-3, hardcover, 300 pages, $29.95.

The New Patterns in the Sky: Myths and Legends of the Stars by Julius D. Staal, (McDonald and Woodward Publishing, 1988), ISBN 0-939923-04-1, softcover, 300 pages, $14.95.

Pathways to the Universe by Francis Graham-Smith and Bernard Lovell, (Cambridge University Press, 1988), ISBN 0-521-32004-6, hardcover, 239 pages, $24.95.

The Unfolding Universe: A Stellar Journey by Lloyd Motz and Jefferson Hane Weaver, (Plenum Press, 1989), ISBN 0-306-43264-1, hardcover, 379 pages, $24.50.

History

Dark Sky Legacy: Astronomy's Impact on the History of Culture by George Reed, (Prometheus Books, 1989), ISBN 0-87975-541-5, hardcover, 199 pages, $24.95.

Dunsink Observatory: 1785-1985 by Patrick A. Wayman, (Royal Dublin Society, 1987), ISBN 0-86027-020, hardcover, 353 pages, 25 Irish pounds.

Nevil Maskelyne: The Seaman's Astronomer by Derek Howse, (Cambridge University Press, 1989), ISBN 0-521-36261-X, hardcover, 280 pages, $59.50.

On the Glassy Sea: An Astronomer's Journey by Tom Gehrels, (American Institute of Physics, 1989), ISBN 0-88318-598-9, hardcover, 340 pages, $35.00.

Race to the Stratosphere: Manned Scientific Ballooning in America by David H. DeVorkin, (Springer-Verlag, 1989), ISBN 0-387-96953-5, hardcover, 406 pages, $39.50.

The Rise of the Wave Theory of Light: Optical Theory and Experiment in the Early Nineteenth Century by Jed Z. Buchwald, (University of Chicago Press, 1989), ISBN 0-226-07886-8, softcover, 474 pages, $24.95.

Schrodinger: Life and Thought by Walter Moore, (Cambridge University Press, 1989), ISBN 0-521-35434-X, hardcover, 513 pages, $39.50.

Selected Papers — S. Chandrasekhar, Vol.1: Stellar Structure and Stellar Atmospheres, (University of Chicago Press, 1989), ISBN 0-226-10090-1, softcover, 515 pages, $29.95.

Selected Papers — S. Chandrasekhar, Vol.2: Radiative Transfer and Negative Ion of Hydrogen, (University of Chicago Press, 1989), ISBN 0-226-10093-6, softcover, 622 pages, $29.95. ☐

focus camera

$18 VALUE **FREE** $18 VALUE
focus ASTROPACK
- **Guide to Astronomy**
- **Astrophotography Basics by Kodak**
- **Professional Optical Maintenance Kit**

w/Purchase of Any Telescope

Enjoy Astronomy At Down To Earth Prices

For Orders Only Call
800-221-0828
Information Hotline **(718) 221-0828**

We Ship Only Brand New Latest Model Factory Packed Telescopes

CELESTRON®

SUPER POLARIS C8
STARBRIGHT COATINGS
SAVE OVER $1000 ON THIS SALE PRICED CELESTRON SCHMIDT CASSEGRAIN TELESCOPE
- **8 inch F/10 Schmidt Cassegrain Optical System**
- **Starbright Multi Coated Optics**
- **World Renowned Super Polaris German Equatorial Mount**

$1069

Complete Factory Pack Includes:
Field Tripod, 6x30 Finder, Star Diagonal 26mm 1¼" E.P., Polar Axis Finder, Trunk Case
(Celestron Suggested List Price $2138)

SPC-8 Accessory Packages

Astronomical Package #1
Save Over $80
- 18mm Orthoscopic Eyepiece
- Dewstar Dewshield
- Celestron Reference Manual
- Set of Sky Maps

(Sugg. List $144) $\$83^{95}$

Astrophoto Package #2
- Single Axis Drive with Drive Corrector
- Camera Adapter
- Tele Extender
- Piggy Back Mount

$\$228^{95}$

ULTIMA 8 Rugged 8" Schmidt Cassegrain Limited Quantity at this price **$1754**
ULTIMA 11 New 11" Schmidt Cassegrain Telescope w/Quartz Drive **CALL**

CLASSIC 8 **The Classic 8" Schmidt-Cassegrain Telescope Returns**
- 8" 2032 mm f/10 High Quality Optics
- Spur Gear Motor Drive
- High Transmission Coatings

Complete Outfit Includes:
6x30 Finder, Star Diagonal, Wedge
25 mm Multicoated Kellner Eyepiece **$829**

CLASSIC 8 STARBRIGHT **$909**
FOCUS EXCLUSIVE RUGGED LIGHTWEIGHT FIELD TRIPOD **$174**
CELESTRON RUBBERIZED FIELD TRIPOD **204**

C-11 STARBRIGHT **$3249**

NEWEST MODEL
SUPER POLARIS C-80
3.1 Inch Equatorial Refractor
910mm Focal Length, Complete w/50X Eyepiece, 45° Erect Image Diagonal Super Polaris Mount w/Slow Motion Controls, Field Tripod w/Tray **$655**

SPC-102 1000 mm Equatorial Super Polaris Mount .... $\$1049^{95}$
C4.5 NEW 4.5" Newtonian w/Equatorial Mount .... $\$447^{95}$

SUPER POLARIS C-6 NEW
6 inch F/5 Newtonian Reflector w/Super Polaris Equatorial Mount, 6x30 Finder, 18mm E.P., Field Tripod **$765**

NEW **C90 SPOTTING SCOPES**
- 3-5" 1000 mm f/11 Optics
- Can Be Used as a Spotter or Tele Lens
- 8x20 Erect Image Finder
- 45° Erect Image Diagonal
- 30 mm (33x) E.P. • Hard Case

C90 BASIC Basic Spotter Great Value **$352**
C90 MC w/Multi-Coatings **389**
C90 R/C Rubber Covered Scope & Rugged Design **$406**
C90 R/C MC As Above w/Multi-Coat **449**
Super C90 Conversion Kit (f/1¼ & Acces.) **138**
SS80 3.1" 400 mm f/5 Wide Field Multicoated Refractor .... $\$314^{95}$

CELESTRON BEGINNER'S SCOPES

Firstscope 80 3.1" Altazimuth Refractor w/Field Tripod, 45° Diagonal .... $\$458^{95}$
C60E Refractor **258.90**
Complete W/Equatorial Mount, Slow Motion Controls, 5 x 20 Finderscope, 25mm Eyepiece (32X), Star Diagonal Moon Filter, Acess. Tray, Adjust. Wood Tripod,
C60 Same As Above with Alti-Azimuth **$137**

CELESTRON EYEPIECES & ACCESSORIES

We carry a large inventory of all Celestron Accessories & Eyepieces. Call or write for our discount prices

Meade Premier Series
"Advancing The State-Of-The-Art"
- Your choice of 8 or 10 inch F/10 or F/6.3 Schmidt-Cassegrain Optics
- Meade's Exclusive MCOG Multi-Coatings
- LX6 Microprocessor Controlled Drive System

MODEL 30 F/10 MODEL 36 F/6.3
Complete outfit includes: Wedge, Tripod, 6x30 Finderscope 1¼" Diagonal, 25mm MA Eyepiece, Trunk Case.

MODEL 50 F/10 MODEL 56 F6.3
Complete with Wedge, Tripod, 9x60 Polar Illuminated Finder 2" Diagonal, 26mm Super Plossl Eyepiece, Hand Controller D.E.C. Motor, Trunk Case.

MODEL 70 F/10 MODEL 76 F/6.3
Complete with Wedge Tripod, 9x60 Polar Illuminated Finder 2" Diagonal, 26mm Super Plossl, 40mm Super Wide, 6.7mm Ultra Wide Eyepieces, Hand Controller, DEC Motor, Electric Focuser, Digital Readout System, C.A.T. Computer, Trunk Case.

	30	36	50	56	70	76
2080	1389	1589	1689	1892	CALL	CALL
2120	1789	1989	2109	CALL	CALL	CALL

Super Wedge Option on 10" Premier 30, 36, 50, 56 Add $219

All Premiers Come With $1000 In Meade Accessory Coupons

Spring Closeout Sale

Meade MTS Schmidt Cassegrains Limited Supply
SC8 MCOG 8 inch F/10 w/6x30 Finderscope Multi-Coatings & Pier Mount $\$849^{95}$
SC10 MCOG 10 inch F/10 w/8x50 Finderscope Multi-Coatings & Pier Mount $\$1279^{95}$

BUSHNELL REFRACTORS
Astro 155 2.4" Refractor w/5x24 Finder, 58x & 155x E.P., Erecting Lens, Tripod **$89**
Astro 280 2.4" Refractor w/5x24 Finder, 47x, 70x, 140x E.P., 2x Barlow Tripod **$109**
Astro 400 2.4" Refractor w/5x24 Finder, 40x, 64x, 100x E.P., 2x Barlow Tripod **$133**

GIANT BINOCULARS
CELESTRON® PRECISION OPTICS UNITRON® Meade
- Perfect for Astronomy & Low Light Viewing
- Glare-Free Viewing & No Eyestrain
- Exceptional Image • 25 Yr. Warranty

11x80 .... **228** 20x80 .... **239**
Celestron Multicoated .... **CALL**
16x70 Astro Observation **323**
11x80R **Rubberized** .... **CALL** 20x80R **Rubberized** .... **CALL**
Tripod Adapter **18.90**

NEW **Meade 2045-D**
Ultra Compact 4 inch 1000mm F/10 Schmidt Cassegrain Telescope **$634**
Includes: Equatorial D.C. Clock Drive Table Tripod, 5x24 Finder Scope. Diagonal & 25mm 1¼" Eyepiece
Optional Hard Case .... **78** AC Adapter **29**

JIM'S MOBILE INDUSTRIES
"UNSURPASSED IN FUNCTION FEATURES & DESIGN"

MotoFocus:
- Finest Quality Electric Focuser
- Built-in Variable Speed Control .... $\$77^{80}$

MotoDEC:
- **Finest** Dec. Motor For Your **Meade** • Friction Clutch
- **Direct Drive** No Gears to Damage • Variable Speed **$73**

NGC-MAX:
High Quality Easy To Use Computer Guider For Your Meade or Celestron Telescope
- Object Database of Over 8000 Objects
- Easy To Use Digital Display
- Simple To Install • Easy To Use **CALL**

focus CAMERA
4421 -13th Ave.
Brooklyn, N.Y. 11219
ORDERS: 800-221-0828
INFORMATION: 718-436-6262
CUST. SERVICE: 718-871-7608

Orders Shipped Promptly—Mastercard, Visa & **Discover** gladly accepted. You may use your American Express card. No surcharge on Mastercard, Visa or **Discover.** All orders subject to verification & acceptance. Please call/write for shipping, handling & insurance. Written inquiries welcome. Not responsible for typographical errors. HOURS: Mon-Thurs 10-7, Fri 10-4, Sun 10-6. All merchandise available at prices shown while supplies last. This ad supercedes all other ads.

All Telescopes Include Full U.S.A. Warranty, and are Shipped Complete as Packaged by the Manufacturer.

STEREO BINOCULAR VIEWER

Celestron Stereo Binocular Viewer, (Celestron International, 2835 Columbia Street, Torrance, CA 90503; (213) 328-9560), list price $850.00.

A binocular viewer is a device that attaches to the focuser of a telescope. It splits the light from the optics into two beams, sending each to a separate eyepiece. The observer views with both eyes, which most people find more comfortable. The instrument, however, does not provide real stereo depth perception because the telescope is, of course, still just a monocular. But using both eyes at once does improve the view, apparently because the brain places more confidence in images received through both eyes simultaneously. Such images have less "noise" and look more real.

I've been an amateur astronomer for more than two decades and have developed a healthy skepticism toward many new observing aids, including binocular viewing devices of various types. Despite this I now include a Celestron stereo binocular viewer in my stable of accessories because it works excellently.

The viewer is a very well made, heavy-duty unit. It comes ready to attach directly to a Schmidt-Cassegrain telescope's T-adapter or to any 1 1/4" focuser with the 1 1/4-to-T adapter (included). The 1 1/4" adapter also comes threaded for standard eyepiece filters.

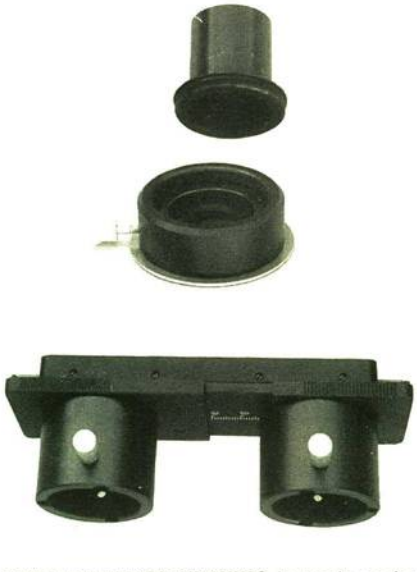
I checked the viewer's light transmission but found no detectable color differences between the two beams after they leave the internal beam splitter, a fault I noted in another make of binocular viewer. To use the viewer, you need matching eyepieces, ideally made by the same manufacturer. You can adjust for slight differences in eyepiece focal length by moving the eyepieces in and out in their holders. (This also lets you make small diopter corrections for vision differences between your eyes.) The adjustment is also easy to maintain because the eyepieces are held in place with thumbscrews rather than simple friction.

The interpupilary distance is changed by pushing or pulling the adjustment grips beneath the two eyepiece housings. Setting this distance correctly is important to avoid both distortion and chromatism in the image, not to mention preventing headaches.

The viewer has a built-in tilt of 45°, and the unit can be rotated to provide convenient orientations for viewing. On the other hand, even with the tilt and rotation you'll still find it awkward to look in certain directions, such as the zenith. The images you see are "normal astronomical": the view is inverted relative to normal eyesight but not reversed left-for-right as with a star diagonal.

A more subtle problem is that with long focal length eyepieces, positioning your eyes is trickier than with a single eyepiece. Finding exactly the right place takes practice; the addition of rubber eyecups on the eyepieces would make it easier. (This is not a problem with shorter focal length eyepieces, which have less eye relief.)

The field of view through the binocular viewer is slightly smaller than that of a single eyepiece. I think this results both from field stops in the viewer's optical path and the slightly increased focal length that results when I increase my Schmidt-Cassegrain's back focus to accommodate the longer light path of the unit. (Warning to Newtonian users: Make sure your optical system lets you move the focal point outside the tube far enough to focus the viewer; you'll



LONG-DURATION VIEWING is made easier with Celestron's binocular viewer. Although designed for use with Schmidt-Cassegrains, it will also work on refractors and some Newtonians.

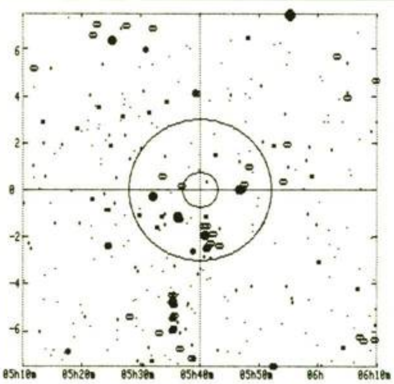
METEORITES!
Irons. Stones. Stony-irons. Tektites. Space jewelry, books, display stands, slides, metal detectors. Authenticity guaranteed. Catalog $2. (Refundable)
Bethany Trading Co.
P.O. Box 3726-A
New Haven, CT
06525
★ CATCH A FALLING STAR!
(203) 393-3395

CHROMA-SCAN POCKET FILTER
- 8 color card for planetary observation $12.95
- 3 light pollution/nebula filters and diffraction grating card for observing deep sky objects and for viewing stellar spectral emissions $15.95
- 3 neutral density filter card for viewing the brighter planetary or stellar objects $8.95
- Send Check or Money Order
- CA res. add 7% sales tax

COLE Enterprises
P.O. Box 3235
Hemet, CA 92343
714-654-8991
CHROMA-SCAN

QUASAR OPTICS
"Western Canada's largest stocking telescope dealer."
BINOCULARS
BOOKS
ASTRO MAPS
POSTERS
SPOTTING SCOPES
TELESCOPES
SALES — REPAIRS
CONSIGNMENTS
CATALOGUE $4.00
-CANADA-
(403) 255-7633
7220A FAIRMOUNT DR. S.E.
CALGARY, ALBERTA T2H 0X7
-CANADA-

SkyBase 2000.0 Plus SkyChart
Star Charts - Your Way



REVERSED IMAGE STAR CHART OF ORION

Make custom finder charts for comets deep sky objects or astrophotography
Use as an observing aid on a laptop
Plots charts Reversed Inverted Normal
Select RA and Dec - Center or Range
Use NGC or Messier Number
ID of deep sky objects with mouse or cursor
45,000 stars thru Mag 7.9
(258,277 stars from SAO optional)
10,000 deep sky objects from Saguarro Astronomy Club Database
IBM PC, compatible or laptop 640K Graphics required
Epson dot matrix or HP LaserJet compatible printer
Supports Microsoft Mouse 80x87 Hard disk
Order for only $49.95 SAO $30.00 add'l
$4.00 S&H (CA add 7% tax) Specify floppy size
SKYBASE SOFTWARE AND COMPUTERS
450 Spring Hill Drive Morgan Hill CA 95037

need about 6" of extra travel. Observers with refractors probably won't have a problem if they can move the telescope's draw tube inward the requisite distance.)

I did not get a strong perception of three dimensionality with the unit, but it nonetheless provided much more comfortable viewing during long observing sessions, such as the occultation of 28 Sagittarii by Saturn last summer. Despite a weak, slightly distracting internal reflection when I looked at Jupiter, I felt that my perception of detail in both planetary and deep-sky objects was subtly increased. I also found that the field of view is dimmer with the viewer, but given that the incoming beam of light from the telescope's main optics is divided in two, I'm not surprised.

For long-duration observing this is a very well made accessory. Its price is steep, even with the discounts you can get through dealers, but the comfort and two-eyed perspective is rewarding. — *Stephen Edberg*

SOFTWARE

The Dance of the Planets software, version 1.3, (Applied Research and Consulting, 2938 N. Madison Avenue, Loveland, CO, 80538; (303) 663-3223), two floppy disks and manual, $165.00.

This is really a remarkable package that makes excellent use of EGA graphics. I have experimented with several ephemeris programs and find this one fascinating. While there are a few things it can't do, *Dance* does everything else so well that I can pretty much overlook its shortcomings.

Dance runs on any IBM PC, AT, PS/2, or compatible computer having at least 512K of memory and EGA or VGA graphics. A math coprocessor speeds the simulation about five-fold, but I was satisfied with the program's performance on my 16 MHz, 286 machine without a coprocessor.

Dance computes and displays the motions of the planets against a field of 1,500 stars through magnitude 5. You can select an earthbound viewpoint or one in space. The viewing direction can be set to give, for example, an oblique or a straight-down look at a planet.

Simulation speeds are controllable, with relative rates from 1 to 20,000 in both forward and reverse time, as well as magnification zooms from 0.5x up to 32,000x. At higher magnifications planetary surface detail is presented and day/night phases are accurately displayed.

Astroscan 2001
WIDE FIELD Telescope

The Stargazers Choice

Reach out and explore the night sky. Unique award-winning design allows you to cradle it in your arms or it glides smoothly and solidly into its table-top base. Highlights of this scope are its extra wide 3° field and its superb light-gathering ability with large 4⅛" clear aperture to resolve panoramic vistas. Optional image erector adapts scope to view land objects. Focuses 25 feet to infinity. System is sealed to protect against dust and moisture and is permanently collimated at the factory

Astroscan 2001: Includes telescope, base, 28mm RKE® eyepiece, finder sight, dust cap, carry strap, 36 page instruction book and 36 page sky guide. **$379**

A wide assortment of accessories are also available.

Economical First Telescope

The Edmund 3" F/6 Reflector

Edmund Designed and Engineered

#31,308 – 3" Reflector Telescope $199.95

#31,639 – 3" With Image Erector $275

Adventure in the night sky. Performance that will develop children's interest as they look with awe at the vast craters of the moon, brilliant Nebula, Jupiter's many moons and deep space star clusters. The wide 1.6° field makes it easy to find sky objects, the 30X magnification with 15mm RKE® eyepiece is ideal for both the moon and deep sky objects. The heart and pride of our 3" F/6 system is the professional-grade optics, ground and polished in our own manufacturing facility from the finest optical glass components.

the Edmund RKE® Breakthrough

Now, a new standard in eyepiece performance at a price you can afford. Edmund optical engineers were able to develop a moderately priced, three-element system which outperforms designs using four or more optical elements. The exclusive design of the RKE® eyepiece family coupled with the quality of its optics admits more light, is free from false color and offers a sharply-focused, wide-field view. Focal lengths: 8, 12, 15, 21 and 28mm **$44.95**

For the name of your nearest Astroscan® dealer, or for a free copy of the Edmund Scientific 172 page catalog call or write
(609) 573-6250

SERVING ASTRONOMERS SINCE 1942
Edmund Scientific Co.
Dept. 10A1, C916, Edscorp Bldg., Barrington, NJ 08007

THAT STREET LAMP YOU HATE?
Turn it Off — Or On!
Works up to two hundred feet.
No wires, or electrical
circuit modifications.
You don't have to go near it! Do it yourself!
For information send $10.00 to:
Dr. Francis M. Cordell
1018 Holly Ave., South Pittsburg, TN 37380

ASTRONOMY SOFTWARE
Shareware / Public Domain / Commercial
Andromeda Software, Inc.
P.O. Box 1361-R
Williamsville, NY 14231-1361
- Specialists in Astronomy / Scientific Shareware & Public Domain Software for IBM and Commodore 64/128 Computers. Only $3.99 per disk. Write for **FREE** catalog. Specify IBM or Commodore.
- **JOVIAN SYSTEM SIMULATOR** - A Simulation of the Galilean Satellites of Jupiter. (IBM) $24.95. Write for more info.
- **ASTROVIEW** - Planetarium and database. (Commodore 64/128 or Apple IIc/IIe with 64k/80 columns) $39.95. Write for more info.

CANADIANS
KHAN SCOPE CENTRE
YOUR REFRACTOR SPECIALISTS!
Televue Genesis $2030.00
Vernonscope 130mm APO...$2346.00
Vernonscope 94mm APO.....$1275.00
Celestron SPC 102..............$1455.00
Celestron SPC 102 Fluorite..$2950.00
Celestron Firstscope 80.........$649.00
Meade 323 Equatorial............$599.00
Meade 313 ALT. Azimuth $549.00
Celestron C60........................$225.00
Celestron C60 Equatorial.......$399.00
WRITE OR CALL FOR DISCOUNT PRICELIST.
SEND $3.00 FOR NEW 1990 CATOLOG!
247 Marlee Ave., Unit 201, Toronto, Ontario,
Canada M6B 4B8 (416) 783-4140
DEALERS FOR: MEADE / TELRAD / CELESTRON / LUMICON
MOTOFOCUS /TELEVUE / LOS MANDY / SURESHARP
VERNONSCOPE / OMCON --- AND MANY OTHERS

INDEX CARD FINDER CHARTS
75 - 3×5 charts per set. For use at the telescope!
AC-1 **MESSIER OBJECTS:** AC-2 **FINEST NGC OBJECTS**
AC-3 **DOUBLE STARS:** AC-4 **FINEST NGC, part B**
AC-5 **NGC FOR LARGER TELESCOPES (Min. 8 - inch)**
$7.50 each, 3 or more sets — $7.00 each
OBSERVER'S GUIDE A bi-monthly telescope guide. With finder charts, photos & visual descriptions. USA $12, 2 yr-$21, Canada $18, OTHER COUNTRIES $18.
OBSERVER'S LOGBOOK with 100 forms $18.95
VIDEO TAPES (VHS or BETA) *(VHS/PAL) $29.95 ea.
***AMERICA IN SPACE, *APOLLO 11, *MARS/MERCURY, *JUPITER/SATURN/URANUS, *UNIVERSE, *SHUTTLE 1 to 8, *SATELLITE RESCUE, COMET HALLEY, STS-1.**
TAPE PROGRAMS with 40 slides — $14.95 ea. APOLLO 11, APOLLO 17, COMET HALLEY, JUPITER, MARS - Viking, SATURN - Voy. 1, SATURN - Voy 2, STS - 1, STS - 2, UNIVERSE, DIXON SPACE ART, BONESTELL'S SPACE ART, GENESIS.
SPACE SPECIAL Galaxies, Solar System 100 slides $32.95
20 SLIDE SETS. Mercury, Venus, Mars, Jupiter - Voyager 1, Jup. Voy. 2, Saturn - Voyager 1, Sat. - Voy. 2, STS - 1, BEST STS. COMET HALLEY, Uranus, Universe. **$9.50 ea. set.**
Send 45¢ stamp for FREE catalog. Outside USA add 20% extra.
ASTRO CARDS Phone 412-295-4128
P.O. Box 35, Natrona Heights, PA 15065

Get your free
F.C. Meichsner Co.
mail order price list!
Just write us at
182 Lincoln St.
Boston, MA 02111
Or call us at
1-800-3-2-1-View
and ask for one!

The simulation even shows the frequent eclipsing of the Jovian and Saturnian satellites by their respective planets. *Dance* shows both moons of Mars, sixteen at Jupiter, thirteen at Saturn, five (plus rings) at Uranus, eight (plus rings) at Neptune, and one at Pluto.

Dance also has a library of about 4,000 asteroids and 1,300 comet apparitions. Although you can display orbits of these objects quite effectively, the program will simulate the movements of no more than twenty objects at a time. You can, however, display the positions of all 4,000-odd asteroids at once. This makes the asteroid belt look really crowded — no space flights through there for me!

You can select whatever object you want to display and eliminate unwanted ones. Gravitational interactions are computed, which lets you see, for example, the interaction of the satellites of the outer planets. During simulations you can toggle orbit plotting on or off. A third choice plots the orbits in 3D using separate red and blue traces. These are viewed through colored glasses supplied with the package. A handy feature lets you adjust the amount of 3D separation.

An identification feature names stars and solar system objects when toggled on. You can lock on to any desired major object (except the Moon) and it will stay centered in the screen as program-time progresses.

Dance also has a resume feature, which allows you to save the parameters of the present simulation on disk for later use. Also, whenever you exit the program your most recent setup is stored automatically.

What *Dance* can't do is a bit unfortunate. You can lock onto any planet, including Earth, but you can't lock onto the Moon to simulate the appearance of a solar eclipse as seen from any location. Hard-copy printer support is minimal. With my version, only a Hewlett-Packard printer works properly, although printers that incorporate the full IBM character set work almost as well. My old Epson, however, just sits there. I can print out tables of orbital data, coordinate positions, and the like, but none of the visuals. More printer support is planned for later releases, but inquire before you buy if this feature is important to you.

To sum up, *Dance of the Planets* is an excellent program. It would be quite useful to schools fortunate enough to have a computer with EGA or better graphics, and to amateurs who like to explore planetary motions. The manual goes into great detail about solar system mechanics and gives you lots of suggestions for interesting simulations to run. The manufacturer promises that version 1.5, scheduled for release in early 1990, will have full VGA graphics and a file of 6,000 to 9,000 stars and deep-sky objects. — *James Bailey*

OBSERVING ACCESSORIES

Paracorr™ Coma Corrector, (TeleVue Optics, Inc., 20 Dexter Plaza, Pearl River, NY 10965; (914) 735-4044, FAX: (914) 735-4112), $395.00.

TeleVue is marketing a new accessory lens that compensates for the coma inherent in all parabolic mirrors. On Newtonian and Dobsonian telescopes the Paracorr is designed to produce sharper star images over a wider field of view. It is usable both visually and photographically. (The Paracorr is not suitable for refractors or Schmidt-Cassegrain scopes.)

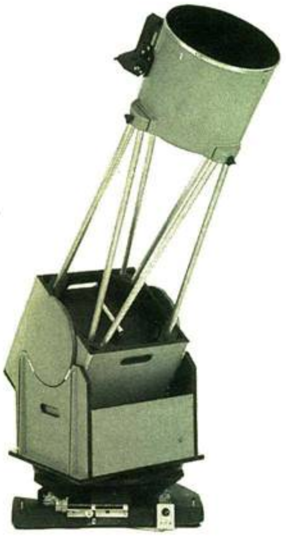
The Paracorr installs like a Barlow lens so it can be used with any telescope that has at least half an inch of eyepiece travel inside of focus. It has a slight Barlow effect, increasing the magnification of each eyepiece by 15 percent. TeleVue claims that star images are seven times smaller at the edge of a 35mm film frame when using a Paracorr in prime-focus photography.

Visually, the Paracorr can be combined with TeleVue's Nagler eyepieces (which are corrected for astigmatism) to produce a field of view in fast Newtonians that is free of off-axis aberrations. However, the Paracorr will work with any eyepiece. According to TeleVue, the Paracorr does not compromise on-axis sharpness or introduce color.

The 2-inch Paracorr, which accepts

THE PARACORR reduces coma in fast Newtonian telescopes, yielding sharper off-axis star images.

2-inch diameter eyepieces, comes in three sections: the optical assembly which accepts T-rings for photography, a 2-inch eyepiece holder, and a parfocal adapter for 1¼-inch eyepieces. Also available is a 1 ¼-inch Paracorr.



THE JUNO-14 SYSTEM provides a large-aperture alternative for those who don't want to sacrifice equatorial tracking.

NEW TELESCOPE

Juno-14 Portable Equatorial, (Jupiter Telescope Company, Inc., 815 S. U.S. 1, Suite 4-237, Jupiter, FL 33477 (407) 881-1365), $3,495.00 with mirror and equatorial table.

This 14-inch f/4.5 telescope system offers a large aperture plus an equatorial tracking platform for high-power viewing and astrophotography. Using a design invented by Georges d'Autume, the platform offers better stability and tracking plus a wider latitude range than previous Poncet-style platforms. The telescope features a 1.75"-thick, 1/20th wave primary with 9-point flotation, 1/10th wave multi-coated secondary with 18 percent obstruction, Novak hardware, a low-profile focuser, and a Telrad finder. The telescope disassembles using a hand-locking truss system.

The d'Autume platform has a worm and sector gear drive, which provides seventy minutes of tracking, and DC stepper motors with a hand controller.

The Juno-14 is also available without the equatorial platform and without the primary mirror. An astrophotography accessory package is available. ☐

The Best from Meade TeleVue & Celestron!

Meade 8-inch & 10-inch Premiers!

Call Toll-Free for Shutan's Meade Prices!

Celestron Ultima 8/11, Classic 8 & C90's

Call Toll-Free for Shutan's Celestron Prices!

Genuine Meade Acc'ys

Accy case 5o ...	$79	Off-axis syst ..	$169
Accy case 54 ...	22	Piggy brkt 8" ...	34
Cat computer ...	995	Piggy brkt 10" .	34
Dec 39 LX5/6 ...	99	Sky/dust seal ..	49
Digital readout ..	call	Set circle illum .	44
Elec foc 1200 ...	179	Star diagonal 2"	139
Elec foc 1200A	169	Tele extender ..	37
Filter set of 6	94	Tele comp syst	69
Filter set of 10 ..	159	T-adapt-std	37
Illum EP 419	99	T-adapt-vari	59
LED map light ..	29	T-mt.-non AF ...	14
Lenshood 8"	59	T-mt.-AF	19
Lenshood 10" ...	94	Vari pol 905	49
Nebula 1-1/4" ...	69	Weight set 8" ..	94
Nebula 2"	109	Weight set 10"	99
Nebula rear-cel	119	WFAS	119

Mention this ad for *FREE* shipping!

Solar Filters in stock!

Highest quality 1000 Oaks • SafeType II glass!

4" **$79** 6" **$109** 8" **$129** 10" **$139**

MotoFocus & MotoDec for Meade and Celestron!

Fully compatible with all mfr. hand controls!

Electric Focus with variable speed!	**Electric DEC with variable speed!**
To fit LX2/3/5/6 **$92**	To fit LX3/5/6 .... **$85**

ASA 3200 Color Film!

Konica film assures shortest possible exposure without the inconvenience & expense of Hypering!

Five (5) 24exp. rolls for $31

Mention this ad for *FREE* shipping!

Meade 2045 *In Stock!*

Meades new 2045 features a dc pulse motor drive, fork mt., 1000mm Schmidt-Cassegrain optics, table tripod legs, and slow-motion controls for RA and DEC.

TeleVue Refractors!

Shutan now carries the newest versions of TeleVue's popular Genesis, Oracle & Renaissance! Call for our discount price on these high-quality refractors!

Meade Eyepieces/Barlows

Ultra Wide		**Super Plossl**	
4.7mm	$139	Up to 26mm	$79
6.7mm	169	32/40mm	109
8.8mm	209	56mm	175
14mm	239	**Super Wide**	
Series II Ortho		13.8mm	125
4/6/9/12.5mm	52	18mm	139
Barlows		24.5mm	149
122 1-1/4" 2x ..	49	32mm	219
140 1-1/4" 2x ..	74	40mm	279

Meade 2" Mirror Diagonal $^{\$}139^{00}$

New TeleVue's w/Eyeguard!

Plossl		**Naglers**	
Up to 26mm	$79	4.8mm	$144
32/40mm	95	7mm	179
55mm	204	9mm	215
Wide Field		12mm Type2 ..	249
15mm	129	16mm Type2 ..	279
19mm	139	20mm Type2 ..	345
24mm	159		
32mm	229	**Barlows, 1-1/4"**	
40mm	289	2.5x or 1.8x	79

Mention this ad for *FREE* shipping!

SHUTAN camera & video

Our 73rd year providing the finest service!

Write for your FREE COPY of our 64-PAGE Discount Buying Guide! All products include full factory packaging. Many items include FREE UPS shipping in continental U.S. Always call for current stock/price info— ads are placed 60+ days prior to publication!

Visa, Mastercard, Check, Cash C.O.D.

SHUTAN
camera & video

312 W. Randolph • Chicago • 60606
M-F 8:30-5:30 • Saturday 9-5

☎ *Call Toll-Free!*
800-621-2248
Illinois 312-332-2000

METEORITES
AVAILABLE TO
ASTRONOMERS, SCHOOLS
INSTITUTIONS AND PRIVATE
COLLECTORS. STONES & IRON
SPECIMENS. **LIMITED SUPPLY.**
ROBERT A. HAAG — METEORITES
Box 27527, Tucson, AZ 85726
— PLEASE SEND $2.00 FOR FULL COLOR CATALOG —
Refundable on first order

Evaporated Metal Films
Astronomical coatings since 1936
6" dia. $20.00
8" dia. $31.00
12" dia. $49.50
(minimum order $35.00)
Write for brochure:
701 Spencer Rd., Ithaca, N.Y. 14850
Phone - (607) 272-3320

ASTRONOMICAL SELECTION
TELESCOPES, BINOCULARS, CAMERAS
CELESTRON
•CLASSIC 8........$799.99
8" Schmidt Cassegrain
•POWERSTAR 4..$1399.99
8" Schmidt Cassegrain w/ Tripod + Wedge
•ULTIMA 8..........$1599.99
w/ Tripod + Wedge
•C90..................$349.99
SPOTTING SCOPE
•C4.5.................$449.99
NEWTONIAN REFLECTOR
LOWEST PRICES ON EARTH
OPEN 7 DAYS · 48 HOUR DELIVERY AVAILABLE
BERGER BROS.
CAMERA EXCHANGE
209 BROADWAY (ROUTE 110) · AMITYVILLE, N.Y.
1 (800) 262-4160 • (516) 264-4160

Dry-Sky!™ Dewshield...$5.00
For your Telrad... It Works!
Lo-Profile Focuser...$125.00
Only 1.5" high, 2"/1.25", Brass R&P!
Collimating Tool Set..$95.00
3 Indispensible Aids for Reflectors!
Telrad Reflex Finder..$42.50
Erect Images. Bull's Eye Reticle!
Projection Reticle....$166.95
Great for Guiding... Illuminated!
Shipping $1.85 per item. 3% VISA/MC.
Catalog $1...Rebateable. Neat Stuff!
astro•tech
101 WEST MAIN ■ P.O. BOX 2001
ARDMORE, OKLAHOMA 73402
405/226-3074
Our 10th Year!

MICHIGAN
Largest Display of Telescopes & Binoculars In The Detroit Area!
Baush & Lomb, Bushnell, Leitz, Nikon, Minolta, Pentax, Fujinon, Swift.
CELESTRON
Authorized Meade Dealer
LOW PRICES
CITY CAMERA
15336 W. Warren
Dearborn, MI 48126
(313) 846-3922
WE SHIP U.P.S.!

Meetings and Events

March 17
Electronics-Oriented Astronomy 3, Chapman College, Orange, California. Sponsored by the Orange County Astronomers. Contact: John Sanford, 2215 Martha Avenue, Orange, CA 92667.

March 22-25
3rd Annual Chiefland Star Party, Chiefland, Florida. Sponsored by the Tampa Area Astronomy Society. Contact: John Novak. Phone: (813) 392-4669.

April 24-27
27th Space Congress, Cocoa Beach, Florida. Sponsored by the Canaveral Council of Technical Societies. Contact: Canaveral Council of Technical Societies, P.O. Box 321333, Cocoa Beach, FL 32932.

April 27-29
2nd Annual Astronomy Weekend, Martz Observatory, Frewsburg, New York. Sponsored by the Marshal Martz Memorial Astronomical Association. Contact: Liz Kalas, (814) 757-9266.

April 28
Astronomy Day. Contact: Gary Tomlinson, Astronomy Day Coordinator, Astronomical League, Chaffee Planetarium, 54 Jefferson Avenue SE, Grand Rapids, MI 49503. Phone: (616) 456-3985.

April 28
Astronomy Day celebration, Charles Hayden Planetarium at the Boston Museum of Science, Boston, Massachusetts. Contact: Noreen A. Grice, Education Coordinator, Charles Hayden Planetarium, Boston Museum of Science, Boston, MA 02114. Phone: (617) 589-0270.

May 5
Astronomy Day, Museum of Arts and Sciences, Macon, Georgia. Sponsored by the Museum of Arts and Sciences and the Middle Georgia Astronomical Society. Contact: Astronomy Day, Museum of Arts and Sciences, 4182 Forsyth Road, Macon, GA 31210.

May 20-28
Texas Star Party, Prude Ranch, Fort Davis, Texas. Contact: TSP Registrar, Dept. A, P.O. Box 386, Wylie, TX 75098.

May 22-27
The 10th Annual International Space Development Conference, San Antonio, Texas. Sponsored by the National Space Society and the Southwest Research Institute. Contact: Carol A. Luckhardt, Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78228-0510. Phone: (512) 522-3823.

June 8-9
20th Annual Apollo Rendezvous and Telescope Fair, Dayton, Ohio. Sponsored by the Miami Valley Astronomical Society and the Dayton Museum of Natural History. Contact: Ian Dumbauld, 5932 Culzean Drive #706, Dayton, OH 45426.

June 30
You and the Universe, Carleton University, Ottawa, Canada. A public symposium sponsored by the Royal Astronomical Society of Canada. Contact: Royal Astronomical Society of Canada, 136 Dupont Street, Toronto, Ontario, Canada M5R 1V2.

July 13-15
Symposium on Automated Telescopes and Global Networking, Boston University, Boston, Massachusetts. Contact: Meeting Information, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112.

July 13-18
Astronomical Society of the Pacific annual meeting, Boston University, Boston, Massachusetts. Contact: Meeting Information, A.S.P., 390 Ashton Avenue, San Francisco, CA 94112.

July 14-15
The Universe in the Classroom, Boston University, Boston, Massachusetts. Contact: Workshop Information, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112.

October 19-20
Twin Lakes Star Party. Sponsored by the West Kentucky Amateur Astronomers. Contact: Jim Boren, Land between the Lakes, Golden Pond, KY 42211-9001.

July 8-12, 1991
Research Amateur Astronomy Symposium, La Paz, Baja California Sur, Mexico. Contact: Corporation for Research Amateur Astronomy, P.O. Box 16542, San Francisco, CA 94116. ☐

Please submit announcements at least four months before the date of the meeting or event.

When you write to organizations listed in Meetings and Events, include a self-addressed, legal-size envelope with your request for information.

Astronomy Software

High Quality Software! Great Prices!
Pick the Ones You Want:

AstroCalc™ - Input time/date & your lat/long and get for Sun, Moon, & all planets: Right Ascen/Dec, Alt/Azm, Ecliptic Lat/Long, Angular Size, Fraction Illum., Elongation, Orbital Elements , Rise/Set Times, Brightness, Distances from Sun & Earth. Also provided are: Local Sidereal Time, Greenwich Sidereal Time, Solar Equation of Time, Twilight Start/End. Heliocentric & geocentric data. **Thousands of satisfied users.** IBM, Apple II, C64/128 **$29.95**

AstroCalc Plus™ - All features of AstroCalc basic version plus: Automatic repetitive calculations (solar/planetary positions or any other data for every hour or day, etc.). Output as ASCII file for use in wordprocessor, etc. or printed output. Visual displays with RA/DEC views, Alt/Azm. views, heliocen. or geocen. overhead views. Greater selectivity of output options & more! Configuration startup file saves location, time zone,etc. IBM & compat **$59.95**

Gravitator™ - Calculates gravitational forces on astronomical bodies such as stars & planets & determines their orbits. See paths plotted & vary scale of view, orientation & angle of view. Input any set of initial conditions, use examples provided or get random sets of clusters. Save systems created to run later or try new conditions. Vary time factor to speed up/slow down simulation. Manual with theory/use. IBM & compat., CGA /Hercules graphics**$39.95**

LodeStar™ - Get accurate, variable size views of the sky for any date & time from 9999BC to 9999AD. Includes over 9,000 stars, Messier objects & Sun, Moon & all planets. Choose any size view from 180 deg. to 0.18 deg., with or w/o constellation lines. Set limiting mag., option for colored stars & size proportional to magnitude. Sun, Moon & planets show actual size & phase at high magnif. See solar eclipses, planetary conjunctions, occultations, transits, etc. Scroll to any object/zoom in or out. Identify stars/objects & get RA/Dec, Alt/Az, Rise/Set & transit times. Calculates refraction, precession , Gregorian & Julian calendars. Get printout of displays w/ graphics printers. IBM or compat., 384K, CGA/EGA/VGA. Works with or without co-processor. **$89.95**

SunTracker™ - Calculates solar eclipse for any date & displays a world map with areas of visibility. Provides dates of eclipses and elements, accurate to 12 miles on Earth's surface. Or input elements to achieve greater accuracy; with EclipseMaster data, accuracy is within 1-mile. Central line of eclipse is plotted on world map & limits of visibility for partial eclipse, which can be specified. Tabular data includes central line location, width, duration of totality & altitude of Sun. IBM w/ CGA, Apple II, C64/128 **$29.95**

EclipseMaster™ - Computes solar & lunar eclipses within 1-mile accuracy for central line, 1/20 of 1% magnitude. Accurate to 3 sec. of arc in longitude & 1 sec in latitude. All aspects of eclipse calculations: central line, local circumstances, area of visibility, duration, width of central line, finding of eclipse seasons for any year. Computes occultation of a star or planet. IBM, Apple II, C64/128 **$29.95**

AstroFinder™ - Night sky realistically simulated for your date/location. Choose any azimuth (0-360 degrees) on your horizon. Print star charts in 4 formats. Manual with star atlas; 30 page star catalog. All Messier objects, deep-sky objects file, add more. Planets & comets tables. IBM & compat. with CGA/EGA, graphics printer. **$59.95**

AstroInfo™ High accuracy data for the Sun, Moon and all planets. Most results accurate to seconds of arc. Select any date from 999BC to 4000AD and any latitude and longitude. Provides position in sky, brightness, rise/set times, & much more. Do searches for conjunctions of objects, distances, and locations in the sky. Generates location tables, or ephemeris, to screen, printer or ASCII files on disk for later use. IBM & compat. **$49.95**

AstroTutor™ - Introduction to all of astronomy, the human side - history of astronomy & astronomers ancient & modern - & the technical side, solar system & planets, stars & their evolution, galaxies and methods of astronomy (observing, telescopes, etc.). For anyone interested in astronomy, student, amateur. Uses graphics & animation to illustrate key ideas.IBM & compat. CGA/EGA/VGA **$39.95**

AstroStell™ - Teaches all 88 constellations plus deep sky objects. Includes: Call constellations by name to screen, Random display to guess names, Names & magnitudes of bright stars, Deep sky objects(galaxies, star clusters, nebula, double stars), Classical lore. Input date/time, & get constellations visible. History of constellations & star charts. Observing tips & using a telescope. IBM, Apple II **$29.95**

Do you have a professional quality original program? We may want to publish it. Write for our programmer's guidelines. Please do NOT send any software or program descriptive materials at this time.

Plus 67 More Excellent Programs!

MasterCard **Order Today!** VISA

☎ 1-800-533-6666 ☎

9-9 MON - SAT Orders Only
For Info or in PA Call 412-422-6600

By phone or mail. Check, M.O., credit card(#&expir.). Add $3 shipping($5 overseas). PA add 6%. Give computer type. Add $1/prog. for 3.5"IBM. Join tens of thousands of satisfied customers in 50 states & 86 countries. Fast shipment!

ZEPHYR SERVICES
The Leading Publisher of Astronomy Software

1900 Murray Ave. Dept. B **Our**
Pittsburgh, PA 15217 **8th**
FREE Catalog-Call or Write **Year**

Galleria

OPTICS
FOR
LAND, SEA AND SKY™

SPECIALS! SPECIALS! SPECIALS!

EQUATORIAL MOUNTS
NOW ONLY $289.00

UNITRON'S 3"
EQUATORIAL REFRACTOR
ONLY $925.00 DEMO MODELS

ONLY AVAILABLE WHILE
SUPPLIES LAST! DON'T DELAY!

LONG RANGE BINOCULARS
UNBEATABLE PRICES INCLUDES
L-CLAMP FOR TRIPOD MOUNTING!

11 x 80mm	ONLY!	$209.00
20 x 80mm	ONLY!	$229.00

NIKON SPECIALS	RETAIL	NOW
7 x 20 Travelite II	$118.00	$59.95
7 x 50 OWL II	$128.00	$89.00
10 x 50 LOOKOUT II	$165.00	$99.00
7 x 35 NATURALIST II	$128.00	$80.00

STEINER SPECIALS	RETAIL	NOW
6 x 30 PILOT SPORT	$289.00	$189.00
7 x 50 PILOT SPORT	$449.00	$289.00

UNITRON SPECIALS	RETAIL	NOW
10-30 x 30 SPOTTING SCOPE	$115.00	$95.00
7 x 42 PRO SERIES BINOCULAR	$260.00	$125.00
7 x 50 UFO BINOCULAR	$150.00	$65.00
8 x 40 ALL WEATHER	$135.00	$55.00
7 x 35 FIXED FOCUS	$99.00	$49.95

CALL US AT:
516-567-2520

All prices are subject to change without prior notice.

59 THE CIRCLE, EAST HAMPTON, NEW YORK 11937

Readings and Resources

Fate of the Solar System (page 20)

Habitable Planets for Man by Stephen Dole, (American Elsevier, 1970). Although twenty years old, this is still the best summary of what makes a planet habitable, especially the chapters on the human requirements and the astrophysical settings.

Return to a New World (page 30)

Project Galileo Fact Sheet, (NASA, 1989). A basic explanation of the *Galileo* mission supplemented by facts, figures, and diagrams of the spacecraft and its trajectory.

Double Asteroid (page 38)

Asteroids II, edited by Richard P. Binzel, Tom Gehrels, and Mildred Matthews, (University of Arizona Press, 1990). A new 1,250-page compendium of what professional planetary astronomers know and suspect about asteroids. Includes a chapter on radar observations of asteroids by Stephen J. Ostro.

Dobsonian Platform (page 52)

"A State-of-the-Art Poncet Equatorial Platform," by Tom Martinez, and "Pursell's Platform: A Southern Alternative to the Poncet," by Wally Pursell, *Telescope Making* #19, Spring 1983, (Kalmbach Publishing Co.). Tom Osypowski took his inspiration for his equatorial platform from these articles.

"A 16-inch Dobsonian on a Pursell Platform," by Tom Osypowski, *Telescope Making* #24, Fall 1984. Osypowski details the construction of his equatorial platform and a 16-inch Dobsonian telescope.

Hunting for the Last Planet (page 58)

Out of the Darkness: The Planet Pluto by Clyde W. Tombaugh and Patrick Moore, (Stackpole Books, 1980). A wonderful first-hand account of the discovery of Pluto.

Planets X and Pluto by William Graves Hoyt, (University of Arizona Press, 1981). A thorough and highly readable history of the Lowell Observatory Planet X searches.

Challenging Clusters (page 64)

Observing Handbook and Catalogue of Deep-Sky Objects by Christian Luginbuhl and Brian A. Skiff, (Cambridge University Press, 1990). A catalog of globular clusters and other deep-sky objects; contains meticulous descriptions of hundreds of objects. □

CREDITS

Cover, page 4: NASA/JPL; *page 10:* NASA Goddard Space Flight Center; *page 14:* Georges Meylan, George Djorgovski, Nick Weir, and Peter Shaver; *page 17:* Space Studies Institute; *pages 20-21, 22-23, 24, 26:* illustrations by Michael Carroll; *page 30:* Joel K. Harris; *pages 31-36:* NASA; *page 37, left:* NASA, *right:* Joel K. Harris; *pages 38-39:* NASA/JPL; *page 40:* Arecibo Radio Observatory, courtesy Steven Ostro; *page 52, top:* Tom Osypowski; *page 64:* David J. Eicher (8-inch f/10 SCT at 50x); *page 65:* Preston S. Justis (10-inch f/6 reflector, 103a-O film, 55-minute exposure); *page 66, top:* Jack Newton (20-inch f/5 reflector, 17-minute exposure), *bottom:* Martin C. Germano (8-inch f/10 SCT, 103a-F film, 60-minute exposure); *page 67:* Martin C. Germano (8-inch f/10 SCT, 103a-F film, 60-minute exposure); *page 77, top:* Michael Stecker, *bottom left:* Howard J. Brewington (8-inch f/1.5 Schmidt camera, hypered Tech Pan film, 1-minute exposure, December 21, 1989), *bottom right:* Paul Roques (4-inch Schmidt camera, Tech Pan film, 20-minute exposure, October 19, 1989); *page 78, top left:* Jack Newton (25-inch f/5 reflector, 30-minute exposure), *bottom left:* Steve Quirk (10-inch f/5 reflector, hypered Ektar 1000 film, 20-minute exposure), *bottom right:* John Hicks (Konica DX 100 film, October 25, 1989); *pages 78-79:* John W. Warden; *page 79, bottom left:* David M. Brewer (video, 11-inch f/10 SCT, November 12, 1989), *bottom right:* Gregory Terrance (16-inch f/5 reflector at f/63, Tech Pan film, November 22, 1989); *page 80:* Rick Schmidt; *page 81:* Jiri Krakora (50mm f/1.8 lens, Vericolor II film, 25-minute exposure).

READER EXCHANGE

WANTED — Members to form a local astronomy club in Durham, NC. Contact Michael Aiken, 3808 Meriwether Drive, Apt. D, Durham, NC 27704. Phone (919) 479-8436.

WANTED — Correspondence with amateur astronomers all over the world. Contact Antonio Ceasar Negreiros, Rua General Osorio, 1280 Apt. 602, 13013 Campinas S.P., Brazil.

ADORAMA
The Photography People
42 West 18th Street • New York, NY 10011
ORDER TOLL FREE 800-233-2500

TELESCOPE ACCESSORIES
LUMICON
UHC PREMIUM FILTERS
1 1/4" 99.50
48mm f/most 2" EP...199.95
DEEP SKY PREMIUM FILTERS
.96"...59.50 1 1/4"......79.50
2" ...119.50 48mm ...119.50
H-BETA
1 1/4....99.50 48mm 199.50
OXYGEN III
1 1/4..99.50 48mm.....199.50
SOLAR FILTER
By Thousand Oaks Optical
GLASS TYPE 2 Stainless Steel Coated MOUNTED
3.1" ....61.95 4" ....71.95 5" 92.95
6" ....99.95 8" ....119.95 10" 129.95
11" ....149.95 12.5" 169.95 14" 199.95
GLASS TYPE 1 Mounted ....Call
JIM'S MOBILE
DEC. MOTOR
f/Meade LX3/5/6/MTS.74.95
for Celestron 8 ....74.95
f/Meade Gem 79.95
FOCUS MOTOR
f/Meade LX3 ....78.95
f/Meade LX4/6 ....78.95
f/Meade Newt 89.95
f/Celestron 8 ....78.95
Mototrac-G (dual axis drive w/remote focus-req. a dec. motor & focus motor) for Meade 295, 320, 660 & Gem models.229.95
Dec Motor f/above 69.95
Focus Motor f/above 69.95
DSC-Max ...499.95 NGC-Max .....749.95 SGT Max....679.95
TELRAD
Finder w/Mounting Base 39.95
IDAI MIRRORS
IDAI 4.5" f/7.8 (860mm focal lens) w/Matching Elliptical Flats 64.95
IDAI 5" f/8 (980mm focal lens) w/Matching Elliptical Flats .89.95
MEADE PARABOLIC MIRRORS
6" f/8 ....118.95 8" f/6 ....183.95 10" f/4.5....409.95
6" f/5 ....139.95 10" f/6 ....369.95 12.5" f/6....599.95
MEADE ELLIPTICAL FLAT SECONDARY MIRRORS
1.3" ....26.95 1.83" ....36.95 2.6" 46.95
1.52" ....33.95 2.14" ....36.95 3.1" 78.95
MEADE RACK & PINION FOCUSER
#67 1 1/4" ....49. #640 1 1/4" ....89. #680 1 1/4" ....109.

CAMERA FOCUSING SCREENS & ACCS
NIKON
B2 (Matte) f/FE2, FM2.19.95
DR-3 Right Angle Finder 86.95
CANON
for F1-N 64.95
for T90....19.95
Angle Finder B 78.95
OLYMPUS
All Matte (1-8) 21.95
Varimagni Finder 79.95
BEATTIE
INTERSCREENS
4x BRIGHTER
Nikon F/F2/F3 ....88.95
Nikon FE/FE2 FM /FM2/FA 53.95
Olympus OM1,2,3,4 ....53.95
F/Other Models..**Call f/Prices**
PUBLICATIONS
Sky Atlas 2000.0 Color ..39.95
Uranometria 2000.0 Vol 1 or 2 ....39.95
The Cambridge Atlas of Astronomy 90.00
Sky Catalog 2000.0 Vol 1 or 2 ....29.95
New Norton's Sky Atlas (18 edt) 34.95
Edmnd Mag 6 Star Atlas 16.95
Celestron Sky Maps....15.95
Passport To The Stars....49.95
Exploring The Sky w/Binoculars 3.95
ASTRO FILM
KODAK
TP (Tech Pan) 135-36.....3.90
TMZ (3200) 135-36 ....4.19
3M
640T 135-36....6.79
1000 135-36....6.99

BINOCULARS
SWIFT
GIANT
Observer 11x80 BCF ...244.95
Satellite 20x80 BWCF ...254.95
SPOTTING SCOPES
Telemaster 15-60x60 ..209.95
Searcher 20x40x60 (12.6")..219.95
Lynx 20-60x65....399.95
Seeker 80mm (32X)....229.95
STEINER
7x50 G 314.95
8x56 MGA 459.95
10x50 G 314.95
15x80 G Observer....629.95
15x80 C Observer w/Cmp.784.95
24x80 Telescop. 459.95
ZEISS
W/O CASE
8x56 CF GA 789.95
15x60 CFT GA....1249.95
30x60 BGAT 899.95
Motor Foc f/30x60 .....159.95
SWAROWSKI
8x56 SL....619.95
10x50 SL....589.95
FUJINON
7x50 Fmt-SX....439.95
10x70 Fmt-SX....549.95
15x80 MT w Mount .2399.95
25x150 RA w/Mount Trpd....9299.95
CELESTRON
GIANT
NEW MULTI-COATED
11x80 MC....294.95
20x80 MC....299.95
14x100 MC....899.95
20x100 MC....919.95
Car Window Mount 69.95
7x42 8x32 Ultima 189.95
8x56 / 10x50 Ultima ...219.95
8x30 / 7x50 / 10x50 Pro ..129.95
MEADE GIANT
11x80 Rubber 269.95
20x80 Rubber 284.95
30x80 CD....319.95
NIKON
7x50 CF Star Vue 146.95
10x50 CF Sentinel....158.95
7x50 SPHP w/cs....519.95
10x70 HP w/case....499.95
SPOTTING SCOPES
W CASE & 20X EYEPIECE
Spotting Scope 289.95
Spotting Scope ED 554.95
New Zoom SS 20-40x60 ..399.95
New Zoom SS ED 20-40x60.599.95
Photo Attachment 119.95
72mm Filter Ring....14.95
Hood 11.95
15,20,30,40, 60x Eyepiece ....Ea 59.95
Lens Scope Converter...54.95
BINOCULAR ACCS
Car Window Mount 34.95

CELESTIAL INNOVATIONS
Binocular Support System f/Giant Binoculars....109.95
SEE OPPOSITE PAGE FOR ORDERING INSTRUCTIONS

ADORAMA

42 WEST 18th STREET • NEW YORK, NY 10011
CUSTOMER RELATIONS • 212-741-0466 • Mon–Thur. 9–4:30, Fri. 9-2 EDT

POPULAR PHOTOGRAPHY CHECKRATED STORE

FAX #
(212)
463-7223

PHONE ORDERS ACCEPTED
DAY OR NIGHT
MON–THURS. 8 TILL 9:30 PM EST
FRI. 8-1:45 • SUNDAY 9:30–6

STORE HOURS:
MON.–THURS. 9–5:45
FRI TO 1:45 • SUN 9:30–5:45

ORDER TOLL FREE
800-223-2500
HAWAII & ALASKA : 800-232-7662

ORDERS & INFO
212-741-0052

COMPLETE w/MANUFACTURER'S ACCESSORIES

Meade®

THE LEADER'S EDGE

$1000 Accessory Rebate Offer w/Purchase of Meade Schmidt Cassegrains

Call for Details

NEW SCHMIDT- CASSEGRAIN TELESCOPES

2080 #30 8" f/10	**1349.95**	*2120 #30 10" f/10	**1759.95**
2080 #36 8" f/6.3	**1569.95**	*2120 #36 10" f/6.3	**1984.95**
2080 #50 8" f/10	**1579.95**	*2120 #50 10" f/10	**2094.95**
2080 #56 8" f/6.3	**1879.95**	*2120 #56 10" f/6.3	**2299.95**
2080 #70 8" f/10	**3119.95**	2120 #70H 10" f/10	**3799.95**
2080 #76 8" f/6.3	**3319.95**	2120 #76H 10" f/6.3	**3999.95**

*For heavy duty wedge instead of reg. wedge add **$225.00**

LX3/LX5/LX6 SERIES (limited availability)

2080 LX3	**1229.95**	2080 LX5	**1539.95**	2080 LX6	**1699.95**
2120 LX3	**1599.95**	2120 LX5	**1899.95**	2120 LX6	**2319.95**

NEW BASIC 2080

A low price 8" Schmidt-Cassegrain Telescope	**899.95**

NEW 2045-D 4" SCHMIDT CASSEGRAIN

Fork Mount, Drive, N/S Switch, DC Operation, 1-1/4" S.D. 25mmEyepiece, 5x24 Finder	**629.95**

NEW CAT/DSC

CAT f/all 2080 Meade	**836.95**	CAT f/German Mounts	**1194.95**
CAT f/all 2120 Meade	**836.95**	DSC f/2080 Meade	**409.95**
CAT f/new Meade LX6	**836.95**	DSC f/2120 Meade	**409.95**
CAT f/Celestron C8, C11	**869.95**	DSC f/Celestron C8 11	**459.95**
Digital Readout System f/LX6	**337.95**		

MEADE EYEPIECES

Super Plossl		Ultra Wide		Super Wide	
6.4, 9.7, 12.4, 15, 20.26	**68.95**	4.7mm	**133.95**	13.8mm	**117.95**
		6.7mm	**159.95**	18mm	**124.95**
32, 40mm	**85.95**	8.8mm (1 1/4, 2")	**186.95**	24.5mm	**134.95**
56mm (2")	**158.95**	14mm (1 1/4 ,2")	**209.95**	32mm (2")	**194.95**
Barlow 2X	**62.95**			40mm (2")	**249.95**

MEADE TELESCOPE ACCS.

Accs. Case #50	**69.95**	Dec #38	**78.95**
Accs Shelf	**26.95**	Dec #39	**89.95**
2X Barlow 1/4" #122	**41.95**	Hand Ctrl. #36	**83.95**
Variable 2X,3X 1/14 #127	**55.95**	Dew Shield (2080)	**56.95**
Rotary EP Holder 1 1/4	**103.95**	Dew Shield (2120)	**94.95**
45° Erect Img 1 1/4" to .96"	**49.95**	Piggy Bk Brkt 2080/2120	**32.95**
Wide Field Adapt Sys	**107.95**	Tube 1401 Weight Set	**81.95**
2" Star Diag w/1 1/4 Adapt	**109.95**	Tube 1402 Weight	**86.95**
Off Axis Guider Assm	**134.95**	Tele Extender	**29.95**
Illum Reticle E.P. 1 1/4	**78.95**	Tele Compressor Sys	**58.95**
Elect Focuser #1200/1200A	**209.95**	8x50 Pol Illum Find	**119.95**
Photo Visual Filt Set 6 pc.	**79.95**	9x60 Polar Illuminated Finder w/Bracket	**134.95**
#1A Sky Filter	**44.95**	#43 R.A. Drive	**79.95**
Set Circle Illum	**36.95**	LED Map Light	**26.95**
#910 Nebular Filter 2"	**106.95**	New! Super Wedge	**384.95**
#908 Nebular Filter 1 1/4"	**59.95**		
#911 Nebular Filter	**109.95**		

MTS TELESCOPES

MTS-SN6 w cs	**519.95**	MTS-SC8 MCOG	**729.95**
MTS-SN6 MCOG	**574.95**		
MTS-SC8 8" w/LX3 Drive & Setting Circles	**1049.95**		
MTS-SN6 6" w/Drive & Setting Circles	**595.95**		
MTS-SN8 8" w/LX3 Drive & Setting Circles	**899.95**		
MTS-SN8 8" w/Drive & Setting Circles	**759.95**		

MTS ACCESSORIES

#788 Drive	**114.95**	#790 LX3 Drive	**359.95**
Setting Circles	**29.95**		
#66A Dec f/SN6, SN8	**39.95**	#66C Dec f/SN8, SC10	**49.95**
#38M Electronic Dec System	**74.95**		
#43 Drive Corrector & AC DC Converter	**79.95**		
6x30 Viewfinder w/Bracket	**62.95**		

REFRACTING/REFLECTOR TELESCOPES

226 60mm Altazimuth	**124.95**
291 60mm Equatorial	**279.95**
312 80mm Altazimuth	**389.95**
323 80mm Equatorial	**459.95**
314 80mm Brass	**899.95**
NEW 4420 4.5" Equatorial Reflector	**369.95**

ACCS for MEADE REFLECTORS/REFRACTORS

Basic Camera Adapter 1 1/4"	**34.95**
Variable Projection Camera Adapter 1 1/4"	**54.95**

SPOTTING SCOPES

Pathfinder II 15-60x Am	**184.95**				
97E 3.5" Compl	**369.95**	97ER	**409.95**	97D	**329.95**

DEEP SPACE TELESCOPES & REFLECTORS

DS-10A	**839.95**	DS-16A	**1689.95**

BAUSCH & LOMB

ASTRONOMICAL TELESCOPES

BAUSCH & LOMB DISCOVERER

78-1600 **15-60x Spotting Scope**	**174.95**
78-9107 Discoverer Case	**44.95**
Tamrac Case for Discoverer	**19.95**
22-3030 Camera Adapt	**19.95**
77-4407 Car Window Mount	**34.95**

SPACEMASTER (60mm)

78 1800 Standard	**138.95**
78-1200 Rubber Armored	**149.95**
78-1817 Standard Kit w/15-45x, tripod and shoulder case	**229.95**
78-1217 Rubber Armored Kit	**249.95**
78-2200 Water Proof w/15x45 Zoom	**294.95**

SPACEMASTER II (70mm APO)

78-1900 **Spacemaster II**	**149.95**
78-1917 **Kit** w/15x45 Zm EP, tripod, shoulder case	**259.95**

ACC. FOR SPACEMASTER 60mm/70mm

15, 20, 25, 60X Eyepieces	**@36.95**		
22X W.A.	41.95	15-45X Zoom	**84.95**
Camera Mount 60mm/70mm	**19.95**		

SUPER-CASSEGRAIN

800mm f/10 Spotting Scope - only 8" long and weighs 1 oz. Comes w/2 1/4" Plossl E.P. (18 & 30) Star Diag and T Adapt	**219.95**

ASTRONOMICAL ACCESSORIES (LIMITED AVAILABILITY)

6mm Orthoscopic 1 1/4	**29.95**
#631049 Camera Mount f/4000	**29.95**

SWIFT

854 1000mm f/12 Cat Telescope w/Fork Drive	**499.95**

Tele Vue®

"Tops in the Field"

NEW PLOSSL		NAGLER	
55mm 2"	**194.95**	20mm Type 2; 2"	**314.95**
40.32mm 1 1/4"	**92.95**	16mm Type 2; 2, 1 1/4"	**229.95**
26, 21, 17, 13mm 1 1/4"	**76.95**	12mm Type 2; 2, 1 1/4"	**224.95**
10.5, 7.4mm, 1 1/4"	**76.95**		

NEW WIDEFIELD		NEW NAGLER	
		13mm 2" & 1 1/4"	**229.95**
		9mm 2" & 1 1/4"	**219.95**
40mm 2"	**272.95**	7mm 1 1/4"	**168.95**
32mm 2"	**219.95**	4.8mm 1 1/4"	**137.95**
24mm 1 1/4"	**154.95**	**BARLOW**	
19mm 1 1/4"	**119.95**	2.5X, 1.8X 1 1/4"	**ea. 74.95**
15mm 1 1/4"	**113.95**		

ACCESSORIES

2" Star Diagonal	**139.95**
Rich Field Kit w New 55 Plossl 2" S.D., Adapt, 2" to 1 1/4" Adapt	**349.95**
1 1/4" E.P. Adapter f Questar	**59.95**

TELEVUE REFRACTOR

NEW UPGRADED! Genesis 4" (101mm) f 5 Fluorite APO The Ultimate Refractor	**Call**
NEW UPGRADED! Oracle 3" (7mm) f 7.4 The Quality Refractor at an Economy Price	**Call**
Renaissance 4" (101mm) f 5.5 Brass Refractor	**Call**

MOUNTS FOR TELEVUE REFRACTORS

TV Panoramic Brass & Wood Alt-Azimuth Mount	**339.95**
Celestron Super Polaris Equatorial Mount w/TV Adptr Plate	**599.95**
Tele Vue Equatorial System Mount w/Wood Tripod, Adpt	**799.95**
Tele Vue Equatorial Mount w/Alum Tripod & Adpt.	**759.95**

NEW PARACORR COMA CORRECTORS

1 1/4"	**184.95**	2"	**289.95**

Edmund Scientific

Astroscan 2001

Edmund Scientific's affordable wide-field, go-anywhere telescope gives super bright images. **278.95**

RKE Eyepieces 1 1/4"	**37.95**	R.A. Prism Erector	**36.95**
8x4-21 Zoom Ortho	**94.95**	Variable Cam. Adapt	**59.95**
2.5 Rke Barlow	**59.95**	Tripod Bracket	**41.95**
Variable Barlow	**29.95**	Carry Bag	**29.95**
		Sun Screen	**39.95**
Straight-Thru Image Erctr	**54.95**		
3" f/6 Reflector	**179.95**		

ADORAMA EYEPIECES & ACCS

Portable Rechrg DC Pk	**69.95**	Rubber Eye Grd f/2" EP	**6.95**
1 1/4 Orth 5, 7, 9	**39.95**	2" to 1 1/4" Adapt	**24.95**
.96" Ortho 4, 6, 7, 9	**29.95**	1 1/4 to .96" EP Adapt Sys	**19.95**
1 1/4" Barlow 2x, 3x	**@31.95**	.96 EP to .96 Focuser	**19.95**
Rubber Eye Grd f/.96	**5.95**	.96 EP to 1 1/4 Focusers	**19.95**
Rubber Eye Grd f/1 1/4 EP	**6.50**	.96 Barlow 2x	**24.95**

CELESTRON®

SCHMIDT CASSEGRAIN TELESCOPES

POWERSTAR 4	**1599.95**

ACCESSORIES FOR POWERSTAR

Dec. Motor	**89.95**	Focus Motor	**99.95**

ULTIMA & CLASSIC 8

Ultima 8	1749.95
New Ultima 11 w/wedge & Tripod	2989.95
New Hand Controller for Ultima	99.95
CLASSIC 8	834.95
CLASSIC 8 with SBC	909.95
Dec Motor f/Ultima & Classic	99.95
Focus Motor w/Remote f/Ultima & Classic	114.95
Adjustable Tripod Rubberized f/Classic 8"	209.95
Davis & Sanford Tripod f/Classic 8	179.95

COMPUSTAR TELESCOPES

Compustar C8	**2999.95**
Heavy Duty Wedge	**229.95**
Compustar C11	**6699.95**
Compustar C14	**Call**

DIGITAL SETTING CIRCLES

DSC For All C8	**269.95**
DSC (Astro Master) f/SP Mounts	**319.95**
New! Advanced Astro Master	**539.95**

SUPER POLARIS C8

Super Polaris C8 with Starbright Coating	**1079.95**

SUPER POLARIS ACCS

Single Axis Drive	**159.95**
Dual Axis Drive	**249.95**
Car Battery Adapt	**16.95**
AC Adapt	**19.95**

NEW STEREO BINOCULAR

For relaxed two eye viewing **469.95**

REFLECTOR TELESCOPES

NEW Super Polaris 6" (SPC 6)	**724.95**
NEW C4.5" Newtonian	**429.95**
Motor Drive f/C4.5 C6 Comet Catcher	**169.95**
Polar Axis Finder w/Illum f/C6, CC, C4.5	**52.95**
Tele Extender Refractor/Newtonian	**44.95**

REFRACTOR TELESCOPES

Super Polaris C102 102mm	**1049.95**
Super Polaris C102 Fluorite	**2199.95**
New Firstscope 80 w/45 Erect Prism	**469.95**
New Super Polaris 80mm (SPC 80)	**629.95**
T Adapter Refractor/C4.5	**32.95**
60mm Altazimuth	**139.95**
60mm Equatorial	**254.95**
Correct Image Eyepiece f/60mm Ref	**19.95**
T Adapt/Tele Extender f/60mm Ref	**43.95**

SPOTTING SCOPES

All the C90s Include: 8x20 Erect Image Finder, 45° Erect Image Diagonal, 30mm, .96" E.P., Foam Fitted Case

C90 Basic	**364.95**
C90 Basic MC	**409.95**
C90 Rubber	**419.95**
C90 Rubber MC	**479.95**
1 1/4" Super C90 Upgrade Kit	**139.95**
C65 Rubber Coated	**197.95**
C60 Rubber Coated	**259.95**
Zoom Master II	**294.95**
SS-80	**309.95**

CELESTRON C90 & SPOTTING SCOPE ACCS.

Cometron 2x Barlow .96	**17.95**	Diag Prism 45° .96	**47.95**
Barlow .96, 2.5, 3X	**Ea. 26.95**	Diag Prism 45° .96 to 1 1/4	**49.95**
4mm Ortho .96"	**46.95**	Series 5 Filter Set	**49.95**
5,6,7,9,12 Ortho, .96	**39.95**	Skylight Filter #1	**34.95**
10,16, 18, 25, 30, 40 Klnr.96	**34.95**	Deluxe Slow Motion Ctl	**46.95**
Zoom Ocular .96	**69.95**	T Adapt. C90	**29.95**
LAR C90	**22.95**	New Photo Tripod	**104.95**
Mult Ocular .96 Hold	**69.95**	New! Shoulder Mount	**77.95**
Porro Prism .96	**44.95**		

CELESTRON TELESCOPE ACCS.

New Improved Accs Cs	**49.95**	Off Axis Guiding Sys	**149.95**
New Fitted Cs f/C8	**149.95**	Photo Tripod Adapt 8"	**49.95**
Barlow 1 1/4" 2x	**38.95**	Piggyback Mt 8"	**36.95**
Barlow 2" 2x	**109.95**	Polarizer Filter Assm	**109.95**
Barlow Lens 1 1/4" 3X	**32.95**	Polarizer Set 1 1/4"	**49.95**
Deluxe Barlow 1 1/4" 2x	**76.95**	Porro Prism 1 1/4"	**49.95**
Counterwt Bar Assm 8"	**114.95**	Rich Field Adapt w/Plossl	**109.95**
Counterweight Set 8"	**59.95**	Series 6 Filter Set	**56.95**
45 Erect Prism 1 1/4"	**52.95**	New Star Diag 1 1/4 MC	**47.95**
Dewstar/Shade 8"	**24.95**	Super Polaris 8" Mount	**579.95**
8x50 RA Pol Find C8	**137.95**	Sky Filter #2	**37.95**
Focus Motor 11, 14	**119.95**	2" Wdstr Diag w/1 1/4 MC	**129.95**
Illum Reticle EP	**99.95**	Adj. Tripod Rubberized	**209.95**
Illum Proj Reticle 1 1/4"	**141.95**	Tripod Accs Tray	**59.95**
Image Corrector 1 1/4"	**19.95**	Tele Extender	**29.95**
LPR #A f 1.1/4" E.P.	**79.95**	Tele Compressor	**57.95**
LPR #B (Rear Cell)	**109.95**	Casters f/Adj Tripod	**39.95**
LPR Filter #2 f 2" E.P.	**99.95**	Vibration Suppr. Pads	**54.95**
LPR Filter #3 f .96 E.P.	**49.95**	Wedge f/C8	**78.95**
Mult Ocular Hldr 1 1/4"	**129.95**		

NEW CELESTRON 1¼" & .96" EYEPIECE FILTERS

(Not all filters available in .96")

Available in the following colors: 1A Skylight; 8 Yellow; 12 Deep Yellow; 15 Deep Yellow; 21 Orange; 23A Red; 25 Red; 38A Blue; 47 Violet; 56 Light Green; 58 Green; 80A Light Blue; 82A Pale Blue; ND 0.3; ND 0.6; ND 0.9	**Each 12.95**
Buy any 4 filters for only	**44.95**
New Polarizing Filter 1 1/4	**14.95**

NEW CELESTRON MYLAR SOLAR FILTERS (MOUNTED)

f/60 Ref	**43.95**	f/80 Ref	**47.95**	f/C90s	**69.95**	f/C90s Rlc	**84.95**
f/c4.5	**69.95**	f/C102	**84.95**			f/C8s	**99.95**

CELESTRON EYEPIECES

2" EYEPIECES

50mm Plossl	**139.95**	32mm Erle	**139.95**	70mm Kellner	**129.95**

1¼" EYEPIECES

5, 6, 7, 9, 12, 18, 25mm Ortho	**49.95**	4mm Ortho.	**49.95**
7.5, 10, 17, 26mm Plossl	**68.95**	30mm Plossl	**82.95**
22, 36, Plossl	**86.95**	45mm Plossl	**94.95**
20,24mm Erfle	**49.95**		
Zoom Ocular (8.4-21mm) Ortho	**108.95**		

WE SHIP PROMPTLY

No Surcharge for MasterCharge or Visa Purchases. Personal checks welcome, will ship without delay. Name must be imprinted on check, also include address, phone, and a copy of major credit card or driver's license for reference. Shipping, handling and insurance additional. 14 day money back guarantee less shipping, with packing and blank warranty card, except film and paper. We ship UPS. Some items special order. All orders are subject to acceptance and verification. Second hand dealer's license #802862. Pictures are for illustration purposes only and may not be exact. **Prices effective till April 3, 1990** **Please address all inquiries and orders to ASTRO. DEPT. #55**

ASTRONOMY Advertisers

April 1990

ACE DOME Inc.	63
Adorama	96-97
Andromeda Software Inc.	92
Astro Cards	92
Astro Enhance	62
Astro-Physics	9
Astro-Tech	94
Astronomics	80
Astronomy Book Club	19
ASTRONOMY Products	17, 61, 62, 75,
Berger Brothers Camera Exch.	94
Bethany Trading Company	90
Caledonian Graphics	63
California Telescope Company	76
Celestron International	11, 100
City Camera	94
Cole Enterprises	90
Coulter Optical, Inc.	82
Dr. Frances M. Cordell	92
Edmund Scientific Company	91
Evaporated Metal Films	94
F.C. Meichsner Co.	92
Focus Camera	88, 89
G.M.R. Productions	62
Galleria	95
Innovative Energies, Inc.	61
Jim's Mobile Industries	84-85
Khan Scope Centre	92
Leica USA Inc.	61
Lewis-Michaels Engineering	61
Lumicon	12-13
Meade Instruments Corp.	2-3
Meteorites/Robert A. Haag	94
Mibro Co., Inc.	84
Minolta	63
National Camera Exchange	41
NightSky Enterprises	61
Nikon, Inc.	62
Nolly Productions, Inc.	69
Optical Research Corporation	63
Orion Telescope Center	56-57
Parks Optical	76
Pauli's Wholesale Optics	68
Prudential-Bache Securities	69
Quasar Optics, Inc.	90
Safari Telescopes	17
Scope City	75
Shutan Camera & Video	93
Simon Schuster	75
Sky Designs	81
Skybase Software & Computers	90
Spectra Astro-Systems	74
Spectra Source Instruments	69
StarLogic Software	63
Swift Instruments	61
Tele Vue Optics, Inc.	7, 62, 99
Tuthill, Roger W., Inc.	15
UNI-POD	63
Univ. of Ariz. Astronomy Camps	83
University of Arizona Press	87
Wholesale Optics of PA	87
WinterTech	62
Zephyr Services	95

Reader Exchange notices are free to all our readers for non-commercial purposes — but only two per person, per year, please. Limit your ad to 40 words including your name and address and allow 4 to 6 months for it to appear. All notices are subject to review for suitability. Kalmbach Publishing Co. assumes no responsibility for statements made in notices or for the quality of advertised items. Send notices to: Astronomy Magazine, Editorial Dept. RE, P.O. Box 1612, Waukesha, WI 53187.

COMING IN THE MAY 1990 ISSUE OF ASTRONOMY

The Solar System in Chaos The motions of solar system bodies are not all as predictable as astronomers once thought.

4th Annual Guide to Astronomy Enrich your astronomy activities this summer with our comprehensive guide to amateur clubs, observatories, planetariums, and museums.

Test Your Telescope Find out if your telescope is a "star" performer and what you can do to fix some common optical flaws.

AVAILABLE ON YOUR NEWSSTAND APRIL 10

READER EXCHANGE

WANTED — Sixteen-year-old seeks correspondence with other teens in North or Latin America interested in astronomy, extraterrestrial life or physics. Will reply to all letters. Contact Edgar E. Lasser, CRA 44# 70-166, Barranquilla, Columbia, South America.

WANTED — Will pay well for *Telescope Making* #4, #13, #17, and #30 in good condition. Contact Mike Caster, 2205 W. Sherman Drive, Muncie, IN 47304. Phone (317) 288-6096 evenings.

WANTED — Southern Hemisphere amateur seeks PD astronomy software for PC. What can I trade or do in exchange? Contact Ron Brown, P.O. Box 6051, Cairns, 4870 Australia.

WANTED — A #784 quartz motor drive system and a Polar alignment view finder for either models 6600 or 8800 Mead reflector telescope. Contact George V. Offerman, P.O. Box 116, 109 Offerman Road, Amasa, MI 49903. Phone (906) 822-7336.

WANTED — *Telescope Making* #4, 17, and 30. Interested in photos of backyard domed observatories and photos of 6" or larger refractor. Also interested in old ASTRONOMY books. Contact Steven Rigdon, 3541 South I-85, Charlotte, NC 28208.

WANTED — The National Geographic Society-Palomar Sky Survey. Must be complete with red and blue emulsions (935 pairs of plates), to –33 degrees. Must be in excellent condition. Contact Benjamin Willett, P.O. Box 162, Buckner, KY 40010.

WANTED — Seventeen-year-old amateur seeks correspondence with others. Planning to go to college for astronomy next fall. Wishes to start astronomy program on local channel, needs facts and information. Contact Kimberly Ann Doherty, 234 Washington Street, Malden, MA 02148.

WANTED — NASA artifacts, anything carried into space, food packs, patches, manuals, hardware, etc. Anything produced and/or used by NASA & the American space program. Contact Paul Hartunian, 127-B East Bradford Avenue, Cedar Grove, NJ 07009. Phone (201) 857-7275.

WANTED — Young amateur astronomer wishes to correspond with astronomy clubs of any size. Local, national, or international. Will pay dues. Contact Joel Clendening, 2116 Sherwood Forest Drive, Miamisburg, OH 45342.

WANTED — An astronomy club that has a good, active number of events, and a yearly fee a 15-year-old can afford. Contact Doug McLellan, 16 Greenwood Lane, Mt. Iron, MN 55768. Phone (218) 735-8651.

WANTED — Information regarding availability of correspondence courses in astronomy. Have been struggling on my own for 4 years and still at dummy level. Contact H. Schutzbier, Naka Ichi Cho 1-10, Yamaguchi-city, Japan 753.

WANTED — Science teacher would like to purchase small diameter primary mirror(s) for beginner/demonstrator Newtonian scope. Will accept unwanted mirrors in need of resurfacing. All f/ratios considered. Contact Albert Jones, 780 Dozer, W. Jefferson, OH 43162. Phone (614) 879-9310.

WANTED — American Ephemeris and National Almanac for the years 1927, 1959, 1960, and 1961. Need to finish set that started in 1909. Contact Gary Kutina, Elgin U-46 Planetarium, Elgin, IL 60120. Phone (708) 888-5324.

WANTED — *Pennsylvania Geology* magazines. Contact D. Copper, P.O. Box 816, New Castle, PA 16103.

WANTED — Young people (teenagers) to join a growing general science club; $5/year. You will receive a quarterly newsletter, plus special issues. To join, contact Daniel Wan, 2658 Dalemead Street, Torrence, CA 90505. This club has existed for more than 2 years!

WANTED — Donation of small parcel of land for permanent dark sky observing site in northern Illinois. Prefer Lake McHenry, Boone, Dekalb, or Kane counties. We are a non-profit organization. Good tax write-off. Will discuss options. Contact Northwest Suburban Astronomers, V.P. Programs, Tom Quinn, 631 Delaware Lane, Elk Grove, IL 60007.

Caress Your Vision

TELE VUE NAGLER 13

Now total viewing comfort is crafted into patented Plössl, Wide-field and Nagler designs. A soft rubber eyeguard cups the eye in optimum viewing position, enhancing contrast by eliminating extraneous light. Larger models have rubber grip rings to firm your grasp. These new features complement designs that started a revolution in optical performance, achieving the highest levels of correction for astigmatism and lateral color.

Winning raves in the latest astronomical textbooks, our 82° apparent field Naglers are still the widest commercially available. And every eyepiece is expert-inspected for full field performance down to f/4 before leaving our hands for yours.

Who is this meticulous maker? Tele Vue, of course. That alone should be comforting.

Tele Vue®

©1989 Tele Vue, Inc.

— Send $3.00 for complete literature package —

20 Dexter Plaza, Pearl River, NY 10965

ULTIMA™ 8

Contact your local dealer today and see for yourself why the Ultima 8 is "Highly Rated" by *Sky & Telescope* magazine. (Jan '90)

AD-LIBS ASTRONOMICS
2401 Tee Circle, Suite 106
Norman, OK
(405) 364-0858

AMERICAN SCIENCE CENTER
5430 W. Latton Ave.
Milwaukee, WI
(414) 281-2322

AMERICAN SCIENCE CENTER
5696 Northwest Hwy.
Chicago, IL
(312) 763-0313

ANALYTICAL SCIENTIFIC
11049 Banbera
San Antonio, TX
(512) 684-7373

ASTRO WORLD TELESCOPES
5126 Belair Road
Baltimore, MD
(301) 483-5100

BILL WEAVER SPORTING GOODS
3515 W. Vickery
Ft. Worth, TX
(817) 731-0804

BOOT'S CAMERA
5587 N. Blackstone
Fresno, CA
(209) 432-0446

CAMERA MART INC.
11 S. Telegraph
Pontiac, MI
(313) 334-9567

CLAIMONT-NICHOLS OPTICAL
1016 1st Avenue
New York, NY
(212) 758-2346

COMPANY SEVEN ASTRO-OPTICS
14300 Cherry Lane Court
Laurel, MD
(301) 953-2000

EDWIN HIRSCH
Box 168 - RR2
Tomkins Cove, NY
(914) 786-3738

F.C. MEICHSNER CO.
182 Lincoln Street
Boston, MA
(617) 426-7092

FELDMAN CAMERA EXCHANGE
300 Oak Street
Wyandote, MI
(313) 284-7244

JIM'S PHOTO SHACK
4100 E. Bay Drive
Clearwater, FL
(813) 536-9661

KING PHOTO SUPPLY
749 W. Lancaster Blvd.
Lancaster, CA
(805) 948-8441

LOS ANGELES OPTICAL
12129 Magnolia Blvd.
North Hollywood, CA
(818) 762-2206

LUMICON
2111 Research Dr., Suite 5
Livermore, CA
(415) 447-9570

MAUI KWIK PHOTO
275 Kaahumanu Avenue
Kahului, HI
(808) 877-7702

MERRITT PHOTO CENTER
103 Merritt Square
Merritt Island, FL
(407) 453-0033

MIKE'S QUALITY CAMERA
1637 Pearl Street
Boulder, CO
(303) 443-1715

MIKO PHOTO & SOUND
1259 Santa Monica Mall
Santa Monica, CA
(213) 393-9371

MIKO PHOTO & SOUND
3200 Sepulveda Blvd.
Manhattan Beach, CA
(213) 546-5491

MILFORD CAMERA
9 River Street
Milford, CT
(203) 878-0156

NATIONAL CAMERA EXCHANGE
9300 Olson Memorial Hwy.
Golden Valley, MN
(612) 546-6831

NORTHERN SKY TELESCOPE
5667 Duluth Street
Golden Valley, MN
(612) 545-6786

OCEANSIDE PHOTO & TELESCOPE
1024 Mission Avenue
Oceanside, CA
(619) 722-3343

ORION TELESCOPE CENTER
10555 S. De Anza Blvd.
Cupertino, CA
(408) 255-8770

ORION TELESCOPE CENTER
2450 17th Avenue
Santa Cruz, CA
(408) 464-0465

PAULI'S WHOLESALE OPTICS
29 Kingswood Road
Danbury, CT
(203) 746-3579

PHIL'S CAMERA SERVICE
11517 S. Dixie Hwy.
Miami, FL
(305) 238-7842

ROGER W. TUTHILL
11 Tanglewood Lane
Mountainside, NJ
(201) 232-1786

S&S OPTIKA LTD.
5174 S. Broadway
Englewood, CO
(303) 789-1089

SCIENCE EDUCATION CENTER
125 S. Hillside
Wichita, KS
(316) 682-1921

SCOPE CITY
3033 S. Bristol
Costa Mesa, CA
(714) 957-6900

SCOPE CITY
2216 Paradise Rd.
Las Vegas, NV
(702) 733-9288

SCOPE CITY
4766 Clairmont Mesa Blvd.
San Diego, CA
(619) 277-6686

SCOPE CITY
679 Easy Street
Simi Valley, CA
(805) 522-6646

SCOPE CITY
3132 Pacific Coast Hwy.
Torrance, CA
(213) 326-3251

SCOPE SOURCE
101 W. Main
Ardmore, OK
(405) 226-3068

STANGERT CORP.
240 Long Beach Road
Island Park, LI, NY
(516) 432-4277

STAR QUEST ENTERPRISES
378 S. Tustin
Orange, CA
(714) 633-8505

STELLAR VISION ASTRONOMY SHOP
1835 S. Alvernon #208
Tucson, AZ
(602) 571-0877

STEWART'S PHOTO, INC.
531 W. 4th Avenue
Anchorage, Alaska
(907) 272-8581

TEXAS NAUTICAL
2129 Westheimer
Houston, TX
(713) 529-3551

VAN TUIL PHOTO
2254 W. 8th Street
Erie, PA
(814) 336-5315

WOODLAND HILLS PHOTO
5352 Topanga Canyon
Woodland Hills, CA
(818) 347-2270

Z OPTICAL SHOP
2829 N. Main
Stafford, TX
(713) 499-4993

In Canada see. . .

EFSTONSCIENCE INC.
3350 Dufferin Street
Toronto, Ontario
(416) 787-4581

FOCUS SCIENTIFIC LTD.
596 Rideau Street
Ottawa, Ontario
(613) 236-7767

HARRISON CO.
3522 Blvd. St-Laurent
Montreal Quebec

KHAN SCOPE CENTRE LTD.
247 Marlee Avenue, Unit 201
Toronto, Ontario
(416) 783-4140

LA MAISON DE L'ASTRONOMIE P.L.
8056 St-Hubert
Montreal, Quebec
(514) 279-0063

PERCEPTOR
Brownsville Junction Plaza
Suite 103, 2nd Floor
Hwy. 27, Schomberg, Ontario
(416) 939-2313

SCIENCE MAGIC INC.
11211 142nd Street
Edmonton, Alberta
(403) 451-6516

YOUNG'S CAMERA
352 Yonge Street
Toronto, Ontario
(416) 597-0055

For more information and locations, contact your local Celestron dealer or call 1-800-421-1526, (213) 328-9560.
P.O. Box 3578, 2835 Columbia Street, Torrance, CA 90503.

CELESTRON®
The First Choice Worldwide